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INDUSTRIAL ADMINISTRATION AND MANAGEMENT

BY

F. L. MEYENBERG

M.I.MECH.E., M.I.EL.E.

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PREFACE

It was the author's intention when he started to write this book to produce a textbook for the Syllabus of Section C of the Associate Membership of the Institution of Mechanical Engineers. The syllabus for the corresponding examinations of other technical institutes, such as those of the Electrical Engineers, the Production Engineers, etc., is so similar that such a book would cover also their requirements. When the author came to prepare students for these examinations, by means of lectures at various technical colleges, two surprising points emerged from his study of the books listed by the Institutions for the guidance of candidates—

1. The majority of these books were of American origin. Although it is fully realized how much the *experienced* reader can learn from them, in spite of the many differences between American and British industrial works and practice, it is certainly dangerous to put into the hands of a student a book putting forward methods and ideas which require considerable adaptation before they can be applied to the working conditions with which the student is familiar.
2. No one book by a British author dealt with the whole syllabus, and to cover it completely it was necessary to have several books. For a lecturer, who probably had these books already, this was no great inconvenience, but it meant that a student, especially if he was unable to attend a course of lectures, was put to considerable trouble and expense if he wished to prepare thoroughly for the examination.

These impressions were confirmed in many discussions with friends and colleagues.

The author at first intended only to close the gap for the benefit of the younger generation of engineers, in whose hands lies the future of British Industry. It was soon apparent, however, that merely to close the gap was not enough, and was in any case almost impossible. Many matters were still the subject of controversy and were likely to remain so for a long time, many methods were more suited to one type of industry than to another, and selection had to be carried out if the book was to remain a reasonable length. Whilst every endeavour has been made to present fairly all important points of view the author's long experience of industry has shown him the fallacies and weaknesses, more often human than logical, which are inseparable from all problems of administration and management, and he hopes that he may have contributed in many cases a new outlook on already well-known matters that may be useful and interesting to a reader of some experience in industry who wishes to gain a fuller knowledge of industrial administration and management.

It may perhaps surprise some readers that the much discussed question of management in nationalized industries is mentioned in only one instance. The reason is that this book deals with the internal problems of management only, and they are not affected by the question whether the concern is a nationalized undertaking or a part of a system of free enterprise. The author believes himself to be a fairly experienced judge in this respect as, of his thirty years of experience of industry, he worked for nearly five years in a leading position in a completely nationalized concern.

Another point which needs perhaps some explanation is the almost complete omission of examples of various kinds of "printed forms," which are essential to all industrial works and which are given so copiously in most books of this kind. It would not have been difficult to reproduce a collection of such forms, but this has not been done because experience as a lecturer has shown that—in spite of frequently repeated warnings to take these forms as *examples* only—many students try to use them in their work exactly as they are shown in the book and without any adaptation. Therefore the character of this book as a textbook which was to make students think and criticize rather than to copy blindly forbade the insertion of these forms, with rare exceptions where they have been considered necessary to facilitate explanation.

It is impossible to enumerate all those to whom the author is obliged for assistance in his work by advice and criticism in discussions or publications, and he hopes that they will accept this brief and sincere expression of his thanks. Where the source of long and important quotations could be traced with certainty it is indicated in footnotes or in the text as far as English or American literature is concerned, but German publications are not referred to in detail—they would be of interest only to a very small number of readers of this book—nor are quotations from the publications of the author himself: those who wish to know of them may be referred to Appendix II of this book.

The author wishes, however, to express his special gratitude to his friend Mr. R. L. Sauvée, A.M.I.Mech.E., of Sovex Ltd., St. Johns Road, Erith, Kent, who has read through the book in manuscript and has made a number of valuable suggestions.

LONDON F. L. MEYENBERG

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INTRODUCTION

Every author should begin by considering his reasons for writing his book. This is especially important in a time like the present, when ideas are subjected to such rapid and fundamental alteration that there is a risk that a book may be out of date before it is printed and bound. A point of equal importance is whether, in view of what already exists in printed form, the author can offer new ideas which are valuable enough to justify the use of labour and material, so scarce in these post-war years, for a task the success of which may be doubtful.

If the present writer has written this book in spite of these reflections, the following considerations have encouraged him. In the forty years that he has been concerned with industrial administration and management in various branches of industry, as employee and manager, as consultant and teacher, in his native land, Germany, as well as in this country which has now been his home for nearly fifteen years, he has seen many changes of opinion, methods, regulations, etc., related to the subjects indicated by the title of this book. How could it be otherwise in a period of which the beginning and the end are marked by two world wars? The fundamentals governing the activities of employees and managers in administrative work have changed only gradually, however, and to this extent it is not to be expected that this book will be out of date for some considerable time.

With regard to the second point, however, the author admits frankly that, as far as he knows, there may be scarcely any ideas contained in this book for which originality could be claimed, but long experience in practice and teaching has produced in the author's mind a picture which is reflected in this book and which it is hoped will be considered as a valuable contribution.

The reader may be reminded that at the time when this experience began, Industrial Administration and Management was considered as "unteachable." Since 1924, the Institution of Mechanical Engineers has added Section C with the title" Workshop Organization and Management" to the Syllabus of its Associate Membership Examination, but in March, 1939, a joint meeting of the Institutions of Civil, Mechanical and Electrical Engineers about the "Importance of a Training in Management for Engineers" had still to be based on the submission "that the two following points be accepted without discussion—

> "1. That the fundamental principles governing sound industrial management are now sufficiently clearly defined to be teachable.
>
> "2. That a knowledge of those principles would be of advantage to an engineer in the pursuit of his profession."

At this meeting the author had the opportunity of developing his ideas as to how, why, and when this teaching should take place, and has since proved in various courses of lectures how far these ideas could be translated into practice. As the spirit of the present book is largely a reflection of the ideas developed on that occasion, some of them may be repeated.

It should never be forgotten that management is an art rather than a science, that it is the spirit in which management is carried on, rather than what is actually done, which should be emphasized, for the latter will vary from one branch of the industry to another, from one works to another. It may even vary in the same works between different departments and at different times. Industrial works are living organisms and have to be treated as such; the persons working in them are individuals and have to be so treated; to a certain extent we have to take them as they are, not as they ought to be. This, however, means that the engineer is here confronted with a type of work unfamiliar to him, where facts, powers, and qualities of material cannot be measured by means of instruments, figures, etc. It needs a reorientation of the mind not easy for teacher and pupil.

It is often asked why every engineer should be taught the principles of management, as only a few will be actually "managers" in later life. This is unsound reasoning, for this knowledge is useful not only for those who will take up the vocation of industrial management but equally for those who will remain the subjects of industrial management. It is often complained—and sometimes rightly—that the young man, coming from technical college or university, is unwilling to adapt himself to the conditions of work in industry. The reason may be that we have taught him to be a draughtsman, a production engineer, a technical salesman, a research engineer, but not an industrial employee. It is the teaching of management which should fill this gap, as far as any teaching can do it, which should prepare a common basis for all work in industry, and which should increase the spirit of co-operation, originating from mutual understanding, and—alas!—so often missing in practical life.

Summarizing, one may say that it should be the objective of teaching in industrial administration and management at our technical schools—

(1) to elaborate the leading ideas of modern industrial life;

(2) to discuss the intricate combination of technical, economic and psychological aspects in industrial works;

(3) to show the importance of each individual works, not only to its employees and employers, but also to its suppliers and customers and to the community.

To which could be added as an additional object—

(4) to pave the way for a uniform professional language in industrial administration and management.

The confusion brought into this world by the "Tower of Babel" is bad enough, but is it really necessary that even the members of the same nation, working together in the same undertaking and supposed to speak the same language, should not understand each other, just because the research worker, the draughtsman, the production engineer, the salesman, and the accountant have all developed their own ways of expressing themselves? This, however, is the situation to-day and it is undoubtedly a great impediment to progress.

ORGANIZATION, ADMINISTRATION, AND MANAGEMENT

The loose use of these three words in practice has undoubtedly done much harm to the understanding of the subject of this book. Therefore it seems necessary to make clear what meaning has been attributed to these expressions throughout the work. The reader will understand that no attempt has been made to find definitions which may hold good from the point of view of the linguist, but only from that of the industrial employee.

First it may be pointed out that the three words do not stand on the same level: while management and administration are functions which are needed in the daily life of the works concerned when dealing with day-to-day affairs, organization is an activity which deals with the development of the general structure of the works and the making of rules and regulations to ensure that the various functions needed in an industrial undertaking work together as smoothly as possible.

Many attempts have been made to explain the essence of all three expressions by short definitions, in order to enable the student *to distinguish them easily or to obtain in practice a means of* deciding in a particular case to what kind of function a particular measure belongs. The well-known *Cost and Production Handbook* of Alford[1] gives two of such definitions for administration, four for management and six for organization. At this stage it seems to be preferable to use a more elaborate method of explanation, which at the same time can be considered as a further introduction to this book.

An industrial works may be characterized as an undertaking where raw material is transformed into goods by labour and these goods are sold to customers. That transformation (usually termed "production") and selling the goods (usually termed "sales") form the two fundamental and indispensable pillars of the undertaking. Although both are necessary and neither can exist without the other, discussion about their relative significance seems to be inevitable. The answer can only be that, if a difference in importance exists at all, it may be only temporary and peculiar to the particular case, and may be reversed in course of time in consequence of changing circumstances.

Production and sales can also be described as the technical and the commercial sides of the concern, terms which are perhaps preferable, as they have a more comprehensive meaning. They are linked by a third function—administration—which has rightly received more and more attention since the beginning of this century, much as it may have been neglected, and even ridiculed in earlier stages of industry. Administration has been spoken of as a "science," and while this may be an exaggeration, the growing importance of this kind of industrial function has been generally recognized.

It is useful in many cases, e.g. for costing purposes, to divide administration into two parts, technical and commercial; but this division will not fulfil its purpose satisfactorily if it is carried so far as to separate the two parts completely, as is sometimes done in practice. As administrative activity is necessary everywhere in a works, this fact should be utilized by making administration a connecting link between the often divergent and even seemingly conflicting interests of the technical and commercial sides of the concern. The nature of technical and commercial activity is so different and their tasks and methods may differ so widely from each other, that such conflicts of opinion should not cause surprise. Obviously, however, conflicts of this kind must be overcome by a suitable compromise; but often special measures of organization are needed for this purpose, calling for firm but smooth handling if the ultimate aim, the prosperity of the concern, is to be attained.

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[1] The Ronald Press Co., New York, 1943, pp. 145–147.

It was, of course, unnecessary to take these considerations into account so long as the industrial structure was simple and the form of concern was the one-man business, or at least did not deviate largely from it. In that case the above synthesis took place in the head of the one man, very often perhaps unconsciously; no real organizing work was necessary; but the more the division of labour developed not only in the range of manual work, but also in mental activities generally and in administrative work in particular, the more the necessity for organization was felt, the result of which is seen in the definition that "organization is the art of using the advantages of the division of labour and of simultaneously avoiding the disadvantages connected with it, as far as possible in given circumstances."[1] It is important at this point to remember that administration and organization are not identical ideas, though unfortunately they can be found used for one and the same function, not only in practice but also in publications.

Organization is only the arrangement of administrative work, the fixing of general principles and rules; organization prevents overlapping and repetition between departments, but it does not carry out administrative measures. That is left to administration proper, and although, from the point of view of the whole concern, organization can be considered as a part of administration—in fact as one of its instruments—the two are very different. For example, planning the production of steam turbines in a new factory is an administrative job, but, carrying out a particular order for such a turbine, when the factory is working, is a matter of organization.

Where an organizing superintendent has been appointed in a works, he will carefully examine the programme of work for the various orders, but he will not interfere with the arrangements made by the production manager; he will draw his conclusions from any delays and friction that he may have observed and try to arrange the organization so that these difficulties may be avoided in the future.

Administrative work, on the other hand, deals with all the details of running the business, from giving decisions in special cases down to the routine work of writing material requisitions and wages tickets, or from the financial operations of investing funds to ensuring that figures are booked to the correct accounts. The function described as "management" is, perhaps, even more closely associated with administration than is organization. This expression has various everyday meanings, and is often used instead of the clumsier "administration," but in industry it tends more and more to mean some leading activity as shown in the terms managing director, general manager, works manager, etc., and it is useful to limit it strictly to this meaning. Management, like organization, is also a part of administration, but it takes a special position in relation to the various divisions of administration in that it overrides them all; thus a general manager can be his own organizer, but he can also depute someone else to do this work temporarily or permanently. Even in the latter case, however, he retains the power of ultimate decision.

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[1] See *The New Management*, by Hildage, Marple, and Meyenberg (Macdonald & Evans, London, 1938).

As already indicated, this explanation of the meaning behind the words organization, administration and management, may not be generally accepted, but it is useful for avoiding misunderstanding when matters of this nature are under discussion, and for our present purpose it seems advisable to establish clearly the relationship between these functions in the way we have done.

This opportunity may be used to consider two "sidelines" closely connected with the above considerations. One is the fact that the term "management" is more and more used not only for the function itself, but also for the persons in charge of this function. In this connection Alford speaks of the groups of supervisors and executives, who make decisions for and give orders to employees or workers. Although in principle it may be deplorable that the same term should be used with two different meanings, no harm seems to ensue in this case, as it is generally obvious which of the two meanings is intended from the context in which the word is used.

The other consideration to which attention may be drawn concerns a special part of administrative work connected with all kinds of industrial activity that may be indicated by the term "Economic Control." In order to make quite clear what is understood in this book by this expression it is necessary to delve more deeply into the development of the general view on industrial activity during the past forty years. If, before the First World War, the question had been asked: "What is the purpose of an industrial works?" the answer would probably have been: "to make a profit." To-day this statement would perhaps be enlarged into the following declaration, in which modern social feeling is reflected: "An industrial success, in the broadest sense, may be considered to be a business result which assures the employer a reasonable profit, allows the staff and the workers to reach a decent standard of living, the production apparatus to receive necessary maintenance and renewal, and takes into account simultaneously the justifiable interests of the customers as well as of the community." It may be added forthwith that these two answers apparently so different do not contradict each other at all; for it is clear—and was so already at the beginning of the present century—that all the demands of employees, of customers and of the nation, as well as those of the up-to-date development of the concern, could only be met adequately if the undertaking was kept sound and efficient.

The public is not always aware that no factual alteration of objectives has taken place, but only a change of expression in order the better to take into account modern social feeling; but the source of the satisfaction of all these demands has always been a sufficient profit.

It is therefore of outstanding importance to have an instrument which tests continuously whether this profit is sufficient and whether the trend of business conditions is such that it can be expected to remain sufficient for a measurable space of time, or whether and why a change for the worse is probable.

This instrument we understand under the term

ECONOMIC CONTROL

It is generally agreed that the operations which comprise accountancy, costing, statistics, etc., effect economic control to the extent that they verify whether the various processes going on in the works are carried out with the greatest possible economy; but the question arises whether this part of administration which may be comprehensively termed "industrial accounts" is really sufficient for the purpose of "economic control," i.e. for making sure that everything has been and will be carried out to the standard best suited to its purpose at the stipulated time and with the least expense possible, when using the existing plant and equipment. That is what the expression "economic control" really means or should mean; and it is obvious that it involves much more than merely keeping accounts expertly and carefully. In general, accounts relate only to money, but economic control extends, as the occasion may require, to measures of quality, quantity, weight, dimensions, number of pieces, etc., and time; and it keeps them in their original form as long as possible, before transferring these figures in some way or other into a money basis, because this conversion may cause uncertainties or mistakes, rendering the drawing of conclusions from the measurements more difficult. On the other hand, only money can be used as the common standard of comparison, necessary for summarizing and obtaining a general survey.

Another point to be kept in mind is that not only is economic control retrospective, drawing its conclusions solely from past experience, but that it has to show how errors and mistakes can be avoided in future.

Finally there is nothing in the works that can be considered as outside the sphere of economic control: from the design of goods, through the planning and preparation of production, through actual manufacture to the dispatch of the goods to the customers, and even to erection on site. The purchasing of raw materials, their testing, transport, and storage, as well as financial transactions to obtain the necessary capital and the provision of ready cash for the wages and salaries, are all parts of this same activity. And if economic control performs its full duty, it must not forget to control itself, but must take care that the control is always governed by the idea of economy and that the saving from the measures taken is greater than the cost. This last demand is more easily made than carried out; for the saving and sometimes also the cost cannot always be expressed by money, and it must be left to the responsible man to decide how high he may set their value in each particular case.

This point of view may also be of importance in other cases; for by defining economic control as a matter comprehending much more than the industrial accounts alone, the foundation of fact has been abandoned to some extent and reliance placed on estimation, based on experience and common sense. This may be considered as a drawback by those who believe in the absolute truth and reliability of accounts, but the expert, more familiar with and always conscious of the "relativity" of such accounts as a basis for anticipating future developments, knows only too well that actually nothing new is introduced into economic control by using estimation. It might be an advantage if this were better appreciated by all concerned than is sometimes the case at present; the danger that the keeping of industrial accounts may degenerate into a mere mechanical accumulation of figures would certainly be diminished.

A textbook covering the material in the syllabus which has just been outlined can only be a survey. It is, in technical colleges, usually compressed into a course of lectures, of say, fifty two-hour periods. Details will be mentioned as examples or illustrations only where necessary. It needs a connecting thread to put the abundant material into some systematic order and to help in remembering the links between the various sections. In the author's experience, to trace the route of a customer's order through the various departments of an industrial concern is the most useful path to follow, and he has therefore chosen as the main skeleton of his book the following five sections—

I. Sales promotion.
II. Design.
II. Production planning and control.
IIV. Execution of work orders.
V. Economic control.

Each section has its sub-sections, or chapters, as indicated in the Contents.

The last of the five sections—Economic Control—should actually not follow but continuously accompany the first four. It will be understood that this is not possible in practice; it is also the opinion of the author that the study of the first four sections will render it easier to appreciate the importance of this fifth and last part, which is unfortunately so often underestimated by technicians and engineers.

PART I

SALES PROMOTION

CHAPTER I

MARKET RESEARCH

Sales and production have been described above as the two fundamental and indispensable pillars of an industrial undertaking and it has also been hinted that it is futile to repeat the discussion of the question which is of greater importance in any particular case.

If in the arrangement of this book Sales Promotion is put first and not, as perhaps the majority of its readers—being technicians—would expect, near to the end, it is because the course of the customer's orders through the works has been chosen as a guide for reasons of clarity. It follows, therefore, that the ways and means of obtaining these orders should be considered first.

One of the main jobs of the management of an industrial works is to keep the *balance between the capacity of its production and the promotion of its sales*. It is equally wrong to accept more orders than can be carried out in the stipulated time limit as to neglect the promotion of orders so that the shops are not sufficiently occupied. In order to keep the balance between demand and supply as level as humanly possible it is necessary to have an accurate knowledge in the first place of the productive capacity of the works, and secondly of the share of the market the works are probably capable of obtaining. If these two questions are asked at the start of an industrial undertaking, the answer to the first could—to a large extent—be given by the management, because it depends on the plan to which the factory will be built, i.e. is more or less in the control of the management; the reply to the second question, however, depends largely on the conditions governing the trade in the commodities which are to be produced, i.e. is outside the control of the management.

At this stage it would be better to postpone the discussion on the productive capacity until the organization of production has been explained.

The problem of the promotion of sales rests on the knowledge of the structure of the market and a special method has been developed, usually termed "market research," which tries to forecast as accurately as possible the extent of the sale of products that can be expected under the prevailing circumstances. It is obvious that this method contains an element of uncertainty which has, in some cases, led to the conclusion that it is practically valueless. Although this opinion may be considered as precipitate, it should be taken as a warning.

Market research has been defined as a method of finding out which influences and facts have to be taken into account in order to obtain with a reasonable degree of accuracy an estimate of the amount of a commodity which can be sold in a definite period of time to all prospective customers, including wholesalers and retailers as well as the eventual consumers. It may be added that not only is this method helpful at the start of a new undertaking, but that once begun it should be continued in order to prevent surprise by changes in the market situation. This kind of research can then be continued as routine work to be used as a basis for a sales campaign. It would be useless to try and explain within the space available this method of market research, as the correct impression could scarcely be obtained in this way. It would appear to be preferable to describe an example; for the method has always to be varied according to the peculiarities of the product in question. While generalities do not give an instructive picture of the measures to be used, it is hoped that the reader will be able to draw his conclusions from the following example without great difficulty.

A machine was developed for improving the keeping properties of milk by a simple and fairly rapid treatment to be done soon after milking by the farmer. It was therefore obviously necessary to find out which areas produced the most milk for consumption elsewhere, as these were the areas where the greatest demand for the machine would be likely to be found. There would be little or no demand in those areas where the milk was consumed locally, as the time between production and consumption was too short and no danger of the milk going bad would arise. On the other hand length of time between producer and consumer was not in itself invariably favourable to the sale of the machine, unless this time consisted almost entirely of travelling time. If the milk had to wait on the farm for a fairly considerable time after milking for transport to pick it up, then it was possible to process the milk by other and cheaper means than the new machine.

A census of all farms producing milk was therefore made to find out the milk production per head of milking stock, and per area of meadow land, and to find which area contained the most dairy farms. These figures were further analysed into those farms from which milk was consumed locally, and those which exported their milk. As might be expected the areas near large towns and cities had the greatest production of milk for "export" from the area.

These "export areas" were divided into zones, classified in accordance with the time elapsing between milking and the reception of the *milk in the town or city. Further investigations* were made to ascertain how much of this time was occupied in actual travelling and how much in waiting on the farm for transport.

From these last two sets of figures it was possible to obtain a factor or constant based on accurate statistics, by which the milk outputs of the various areas could be compared from the point of view of the possible demand for the new milk-processing machine. Thus an area with a high milk output but a long wait for transport might be given a low factor as not being favourable to the sale of the new machine, whilst another area with a lower milk output but a long travelling time and a short waiting time might receive a higher factor.

Even from the above shortened and simplified example of market research it should be clear that for such work a good knowledge of statistics is necessary, as well as practical experience in finding out among all the influences which are working on a market just those that are of special importance for the case in question. It can be stated that there is no product for which the anticipation of the market would not be possible if the correct method, adapted to that product, is applied. Finally, it may be mentioned that, though our explanation has up to now dealt with the isolated investigation of a new market, in some cases when the product has become established, it has proved well worth continuing the observation of the market so as to lead to a better foundation of the supply and production policy of the firm.

CHAPTER II

THE ADVERTISING DEPARTMENT

THE situation as it has been described with regard to the market generally and especially to possible fluctuations in the demand for the commodities produced, makes it clear that the works need to possess an instrument which will enable them always to obtain a sufficient share of the existing demand, or, if for some reason this is not possible, even to create a new demand where none previously existed. The most famous example of this last proceeding is the development of the motor car by Henry Ford, whose enormous success must be attributed to his understanding that it was necessary to change the automobile from a luxury article into an everyday necessity, thus multiplying the demand to an unheard-of extent. If this example were to be analysed it would perhaps be found that the main stimulus to consumption was the decrease of the selling price as a consequence of the increase in production; in another example, say the radio set, it was perhaps the desire for easy entertainment which created a completely new branch of industry. Nearly always, however, it will be found that it was, and is, necessary to assist such a development and to draw the attention of prospective customers to the new or improved commodity by advertisements, which are expedients to inform customers and prospective customers quickly and comprehensively about the kind and extent of the production of the concern in question.

Advertisements

The actual negotiations and the conclusion of the sale remains the duty of the Sales Department proper.

Whether one prefers to separate advertising from sales in two separate departments or to make advertisements the task of a section of the Sales Department will depend mainly on the extent of the business, and also on the persons available and suited to the different parts of the function called "sales promotion." If for some reason or other a separation of the Advertising Department from the Sales Department proper has taken place—it must be emphasized that the close connexion between both functions should not be lost—probably the best way is to subordinate the whole group of departments summarized as "sales promotion" under one responsible man, the Commercial Manager.

There may still linger in the memory of an older generation recollections of the time when it was not "fashionable" for a well-known firm of good repute, with a distinguished clientele, to use advertisements; later, when experience had shown that this attitude might result in a sensible decrease of business even in large concerns, they were considered more or less as a necessary evil, an addition to the technical and commercial work to be done, and so they did not get the necessary attention. To-day advertisements are appreciated as an indispensable feature in business life and the manager of the Advertising Department may be a highly-paid specialist who not only is an expert in all matters concerning advertising proper but also knows the products of the firm—their peculiarities, advantages, and disadvantages—as well as those of its competitors. In addition to possessing some literary ability he must have artistic taste, and an instinctive feeling for what is striking without being obtrusive or suggesting quackery. Further, he has to be familiar with the many highly-developed methods of reproduction in all media, at least sufficiently so to be able to judge the final effect of his designs and their suitability to the medium chosen. At the same time he must be an economist in choosing the best ways to bring the products of his firm to the attention of those who are most likely to be interested.

The methods employed are manifold, the commonest being the insertion of advertisements in *newspapers and journals*; they usually consist of short statements to indicate the characteristics of the product. In spite of popular opinion it is absolutely necessary that statements in advertisements should be based on facts, for no amount of expensive and elaborate advertising claims will in the long run conceal the real defects of the goods offered for sale. A good business man knows that gaining a momentary success is less important than building up a regular clientele as a permanent basis for a good reputation.

The language of such advertisements should be concise and clear; pictures should be used extensively, for they explain, especially to the technically educated, more easily and quickly than long descriptions. It is obvious that the type of advertisement should be chosen to suit the circle of readers who buy the newspaper or journal; it makes a difference too whether an advertisement appears in a political daily or a professional monthly. It is not sufficient to insert an advertisement in a journal once only. Only by a steady and patient repetition of the same, or at least similar, advertisements can the name of the commodity be hammered into the brain of the prospective customer, so that it is recalled almost automatically whenever he needs the commodity advertised.

Advertising Agencies

The acquisition of orders by the placing of advertisements in newspapers and journals is apparently simple, but the expert knows that it is a difficult art, needing a number of different qualities that are not often combined in one and the same individual. No doubt this is why there have come into being special *agencies* which act as intermediaries between the two parties immediately concerned, seller and customer, and which enjoy a middleman's profit. At first sight it seems as though this money could be saved by direct contact between the participants, but whether this would really be the case depends on the particular situation and especially on the extent of the business; a decision must be made on the merits of each case.

Leaflets and Posters

Advertisements may also take the form of leaflets, which are either enclosed in weekly or monthly journals or sent separately by post. These allow of a larger variety of advertising matter but are generally more expensive than advertisements in journals. They are often devoted to specialities of the firm, of interest to a certain proportion of the readers, and in this case the prices of the goods offered are included in the leaflets, which form the basis of price-lists. Folders are given to those customers who can be considered as permanent business connexions, and by collecting these leaflets in the folders they will form price-lists which can be kept up to date by replacing those leaflets that become obsolete. The virtue of this system is that it frequently recalls the name of the firm to the minds of the customers.

The same purpose is served by posters, which catch the eye by their characteristic make-up, their artistic style, their illustration of the use of the advertised commodity, or by their unusual, larger-than-life size, etc. In this connexion may be mentioned illuminated advertisements which have become a feature of our large towns.

Books and Lectures

For some types of firms a successful kind of advertisement is by means of books or booklets dealing with complete plants or describing machines, engines or apparatus that have been delivered and are now working satisfactorily. Lectures on those plants in professional institutions serve the same purpose. Some tact is required with such publications or lectures to avoid giving the impression of blatant advertising, as this might well produce a contrary effect to the one intended.

If, as is frequently the case, especially in lectures on technical matters, the lectures are illustrated by lantern slides or films, these should not be used indiscriminately without taking into account the purpose for which they are to be shown. That is to say, they should be specially prepared for the audience so far as their size, shape, etc., are concerned; what is important in the picture should be rendered prominent and the rest partly or completely screened. All the resources of photography should be used to make it easy to see and understand the objects described. Attention is called to this point because it is often believed that drawings, diagrams, etc., which have been produced for other purposes, e.g. for publication in books, for use in offices or workshops, etc., can be used unchanged for lantern slides. It should be remembered that such drawings and diagrams are often so overloaded with lines, notices, and other detail that the spectator cannot follow them in the short time the picture appears on the screen during the lecture. Special care should be taken in the preparation of these slides, as only too often unsuitable lantern slides have converted what should have been an interesting lecture into a period of dullness and boredom.

Exhibitions

During the second half of the nineteenth century world exhibitions developed enormously, but they have lost much of their importance as their value proved to be out of proportion to their cost. In the last few decades, however, they have been revived again in the form of special exhibitions. There is no doubt that exhibitions of this kind, well organized and tastefully arranged, are a good means of advertisement, but it is also certain that they are more expensive than they appear at first sight.

Generally speaking, it is not sufficient for the exhibited machines, instruments, etc., to compare well with all the other exhibits; there must also be something that strikes the eye of the spectator, for instance a machine in motion or an apparatus at work. Well-planned printed leaflets must be available and, above all, there must be in attendance representatives able to give any information required by the visitors; this appears a self-evident point but experience shows that it is very often overlooked. It is not surprising that exhibiting is costly and does not always pay.

There are many other forms of advertisement, such as the distribution of small articles bearing the name or trade-mark of the firm, e.g. letter-weights, ash-trays, etc. Nor must direct mail advertising be forgotten.

At the present time, of course, advertising is much hampered by various restrictions and its benefits cannot be enjoyed to the full.

Comparison of the Value of Various Kinds of Advertisements

It is often asked when and under what conditions one of the above-mentioned means of advertising should be preferred to another. It is not possible to give general rules for this choice; the manager of the Advertising Department must know, almost by instinct, what is the best means to suit the market situation, to impress the type of customer most likely to buy, etc. He should not, however, neglect any opportunity to find this out by every possible means, by maintaining contact with customers, and wholesalers and retailers, by information from employees of his own firm, and by study of the trade and professional publications, journals on national economy, newspapers, etc.

In order to learn from the past he should also attempt to gauge the success of some measure taken in the past; but this—though frequently recommended—is often very difficult, and sometimes even impossible; at least it is the experience of the author that many of the possible indications are unreliable. How, for instance, are we to find out which incoming inquiries are the result of which current advertisements for the same product? Of course the address given in each advertisement can embody a letter-figure code which will show the source (e.g. Dept. F.T.3, for an advertisement appearing in *The Financial Times* on the third of the month); or we can ask the customers to co-operate by saying from what source they have heard about the commodity in question. Neither of these methods is satisfactory, for frequently people cannot be bothered even to give the Department reference, much less to include a sentence about where they saw the advertisement! So far as they go, however, these systems are reliable.

It is often tempting to try and simplify the organization within the firm and to make its work easier by engaging the co-operation of outsiders such as customers or suppliers, but experience shows that such methods may contribute an element of uncertainty to the organization which only too often counterbalances any advantages.

The Advertisement Budget

It is sometimes concluded from these considerations that choice amongst the many means of advertisement is quite a random one, guided only by a feeling that the case in question is better served by one kind of advertisement than by another. Nothing of what has been said should be understood to imply this. On the contrary it is essential to *plan* an advertising campaign and to distribute the advertising expenditure amongst the various kinds of advertising according to past experience and the possibilities of the future as far as these can be anticipated. Of course a certain flexibility should be kept, as a changing economic situation may need alterations in types of advertising to meet it; but if there is no plan, at least as a general guide, the whole campaign may only too easily give the impression that there is behind it no mind conscious of the aim it wants to attain, and the result will not correspond to the means expended. If this happens it may be decided that advertising is an unproductive extravagance and should be stopped. The result may be that deductions from the advertising budget will take place just at a time when the economic situation demands increased efforts.

There is perhaps no other function in business life which asks more for steadiness, patience, and "working according to plan" than advertising. There are well-known examples of great concerns which, having built up a large turnover with the help of propaganda and advertisement, thought they could decrease their expenditure on advertising, only to find that business went down rapidly and that the budget had to be increased as quickly as possible, much beyond its original figure, in order to restore business to its former level. It is therefore essential to keep to a carefully considered plan and to use all reasonable means to see that it is carried out, unless some deviations should prove necessary.

By means of the usual office methods, which will be discussed later, it should be possible at any time to verify how far it has been possible to follow the original plan and to keep the expenses of the Advertising Department within the limits originally intended. The value of printed matter should be assessed and be considered as the property of the Advertising Department, to be administered like other stores. In large concerns advertising expenditure is allocated and charged to the products for which it has been prepared, and an internal book-keeping system is organized so that the Advertising Department can be costed. It is even possible to calculate a "profit," which may show that the often lamented "unproductivity" of the Advertising Department is due to regarding it only as an expense.

This point is mentioned here as it is only too often found in practice that the work of these "supplementary" departments is not considered important from the economic point of view.

The Extension of the Advertising Department

The Advertising Department possesses figures, drawings, diagrams, photographs, etc., as well as the blocks made from them for the various printing processes, and they represent a considerable value, especially in the case of concerns of some magnitude. Their collection and careful preservation is very necessary as their later use is always possible and cannot be anticipated with certainty even over a long period of time. It has already been remarked that the manager of the Advertising Department must be an expert in these matters: he must thoroughly understand all stages of the production of the materials he uses. In some cases, therefore, it seems only logical that rather than employ the services of outside firms specializing in photography, block-making, etc., the firm itself should set up a properly equipped department to do this work. The advertisements designed by the artists employed by the firm may then be reproduced on the spot.

It may well happen that a "supplementary workshop" of this type grows into a "factory" with quite a different product and with an independent economic life. Without going into further detail it may be remarked that such a branch could expand in many directions depending on the circumstances of the case in question, and before the management of the works expects it a new factory may have grown up whose leading personages have inadequate experience. If this development has been intentional and the management has made provision for everything necessary for the new "factory" in the shape of capital, site, shop, machines, men—not forgetting sufficiently experienced management having the necessary technical knowledge—nothing can be said against this whole development; but in practice it happens only too frequently that the necessary foresight is not exercised. The man who is the specialist in the new branch is perhaps a first-class technician but without the general economic knowledge, the specific experience of the market, and the like; he may be personally interested in the expansion of the department with which he is connected and he may understand how to put the possible advantages of an expansionist policy in the best light, while the drawbacks are not mentioned or at least not discussed sufficiently. The top management, as already mentioned, may not know much about this new branch of industrial activity, and is comparatively easily misled into creating an uneconomic or less economic section of the business. These considerations can certainly not be generalized—economic decisions should always be made by treating each case separately—but the mistake described has so often been found by the author in practice that his advice would be to think twice before being led into a by-path of production.

CHAPTER III

THE SALES DEPARTMENT

It is not sufficient to draw the attention of a prospective customer to the products of the works by means of advertisements. It is rare in present competitive conditions to put through a big business deal without a representative or a traveller of some kind paying one or several personal visits to the customer. It was not unusual in the past—and may even happen to-day—for this activity to be considered with disdain; but anyone who has had to do this job for some period of his life knows how difficult it can be and how great the effort it can demand from mind as well as body. In many cases highly technical work is involved. The customer who wants to buy a machine or technical plant may himself be an engineer and may not be satisfied by general phrases. He may ask for proof in figures or in some other convincing form to show that what is recommended is suitable for the conditions under which it would have to work in his factory and is to be preferred to the products of competitors. Detailed knowledge of what his own firm is able to supply and of the development and performance of their products is therefore not enough, although it is absolutely necessary to the successful activity of a salesman. He must also know what has been done and can be offered by competitors in the same line, with the advantages and especially the disadvantages of their products. He must know how to make the most of the quality of the commodity he is offering and its improvement on what is already on the market, all this without disparaging competing products in any obvious way. If he is selling machines or plant, he must be able rapidly to sum up unusual working conditions, to put down the essentials in a few words, to reproduce a picture of the locality by sketches, which may be superficial but must nevertheless be complete in essentials, so that the work of a colleague in the factory, when he comes to lay out or design the desired plant, is made as easy as possible. He has to persuade the customer without being obtrusive, to dissipate all doubts, to note any alterations in requirements so that they can be included in the final offer or proposal, and often to guide the customer in his choice. Especially, however, he must keep a sense of proportion and not insist on selling if what can be delivered is not suitable for technical or economical reasons, and on such occasions a frank admission to the customer is the best policy. It is much better for a firm to build one plant less, than to deliver a plant which is uneconomical from the beginning. The shortcomings of an unsatisfactory plant soon become widely known.

Costs of Travelling on Business

In view of all the difficulties with which the representative has to grapple it is not possible to treat this profession with contempt; the business man who opens the mail in the morning eagerly expecting the results of the travels of his representatives will be well aware of the value of an efficient "traveller" and will attempt to keep him in his services by granting an appropriate income. When fares and other necessary travelling expenses are taken into account, it is obvious that for some firms the total cost of travelling on business amounts to considerable sums. It is therefore desirable to plan these journeys as well as possible so that no visit is omitted which could have been made with a comparatively small expenditure of time and money. While it is absolutely essential not to overlook business connexions which are already in existence, care should also be taken not to miss any potential customers. The addresses of customers or prospective customers should be kept so that they can quickly be found, classified under the district (country, town, borough, etc.) in which they are situated. This can be done in many different ways of which the card index has proved the most suitable for this purpose. Since this is a convenient juncture at which to deal with the card index, which will be mentioned many times in the course of this book, it will now be described both generally and in detail.

The Card Index[1]

The card index is a collection of loose cards all of the same size, which are put into a box, drawer or cupboard according to some logical order or rule and are used for the collection of notes of a similar kind which it may be of importance for business purposes to find quickly and easily. Card indexes may form a collection of the names of customers or a list of foundry patterns, of machine tools, of stocks in a store, and so on. In its present highly developed form the card index has become an expedient of organization which can no longer be omitted.

Of course it is quite possible to collect the notes in a bound book, but that is not all that is necessary, for in order to be able to find these notes it is necessary to keep an index of the book based on some rule or arrangement. When this book is filled it becomes necessary to start a new book with a new index, which immediately involves the disadvantage of having to look into two indexes to make certain that all information has been found. Alternatively an independent index has to be used from the start, in which case, however, the danger that a reference may be forgotten or omitted is greater than when the book and index are in one. Besides, when such a collection of notes is started it is rarely possible to judge how large the collection will become; it may therefore easily happen that the extent of the index as originally planned is wrong. If it is made too small, nothing else can be done but to add a second in spite of the great inconvenience of having to use and to make entries in two separate indexes instead of one. To avoid this inconvenience the unpleasant and time-wasting labour of rewriting the whole index has to be undertaken. Too large an index makes references difficult to find and leads to much unnecessary work.

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[1] *How to Take, Keep, and Use Notes*, by J. Edwin Holmstrom (ASLIB, 52 Bloomsbury Street, London, W.C.1, 1947).

A further important drawback is that all these books become damaged and torn by frequent use; a renewal, however, as it usually means a complete rewriting, is so expensive or time wasting that it is not done. It also sometimes happens that the notes which have been made in the book are no longer of interest, or are even wrong and need corrections, or extensions of the original entries are necessary, etc. In a book in which, naturally, one entry follows immediately after another, there is not sufficient space, so additions to old entries are made either in a small and correspondingly illegible hand between the old lines, or reference is made to another and later page, which means considerable increase of work and delay in looking it up.

All these defects are completely avoided by using a card index: no separate index is necessary as the cards are always in the required order, and thus all the disadvantages connected with an index in a book disappear; the card index can be enlarged without limits; single cards which have become damaged by frequent use can be replaced without a great deal of work or expenditure; notes which have lost their importance can be removed without disturbing the whole arrangement; and additions can be made in the simplest way by inserting new cards which can easily be found again, as they are put away in their right place.

The card index has the disadvantage that unauthorized persons can easily disturb it by taking out or inserting cards. This can be prevented, however, by the use of fasteners, which allow the cards to be read but do not allow them to be removed from the place to which they belong. Round holes in the cards end in a slot which permits the card to be slipped over the small side of a rectangular bar passing through the whole length of the box. When this has been done the bar, now resting in the round hole, is turned through 90 degrees and locked in place. As its large side is now perpendicular to the slot in the card, the card cannot be removed from the bar, but it can be moved on the bar, so that all notes made on the cards can be read. It may not be superfluous to remark that it will not always be necessary to apply this bar and lock, which renders the use of the card index more difficult and makes the arrangement more expensive; thousands of card indexes are in use in practice which have no such bar and lock and it is always worth considering whether it is really needed.

The important point is to eliminate the possibility of producing disorder in the card index in one way or another. The best method is to entrust it to one person only. He or she is responsible for its maintenance and order, and has to give out any information required to inquirers, and to put in all additions, and in every way to prevent any other person from interfering with the card index. If this employee has to leave the room where the card index is placed, even if only for a short time, this room must be locked. The reader will perhaps be astonished that these details are mentioned, but experience has shown that it is necessary to draw attention to them as they are often neglected and in consequence the efficiency of the card index quickly deteriorates to such an extent that it is finally abandoned.

It is often desirable to have two or three card indexes on the same subject and giving the same reference in two or three different places or in two or three different departments. The ideal naturally is to prepare two or three copies of the cards and to build up completely equal indexes in each place. In practice, however, it is nearly impossible to keep them really the same, and all equally reliable for any length of time. Of course this should not be the case; but we have to consider human nature as it is and not as we imagine or wish it to be.

Reference to card indexes has been made more rapid by the use of coloured cards, known as guide cards, which have projections from the upper edges, sometimes cut to different shapes as well as being coloured, and have letters, figures or signs on them which enable the main heading to be quickly found. If particular attention has to be drawn to certain cards, this can be done by clamping small pieces of cardboard, metal or celluloid "riders" to the upper edges of the cards.

For fuller information about card indexes reference should be made to the catalogues and price-lists of the firms dealing in office supplies and stationery, where information will also be found on the cabinets, boxes and other containers for keeping the cards, as well as lists of printed cards which are available. Numerous examples of complete card indexes with every possible device for rapid reference are also given in these catalogues. Valuable as these examples are, they should always be treated as suggestions only. It will hardly ever be possible to use unchanged one of these examples taken from catalogues and price-lists. Nearly always it will be found necessary to alter the subject headings and the layout of the printing on the cards.

The possibility of classifying notes with relative ease under various quite different headings is one of the main advantages of the card index which has not yet been mentioned. To return to the example with which this discussion originated: a collection of the names of customers should be kept in alphabetical order of their names; but they might also be required to be classified according to districts, and it might further be necessary to classify them according to the nature of their inquiries, and so on. To do this several copies of the cards must be prepared and arranged in a corresponding number of card indexes, one card index for each classification. The danger which is connected with the keeping of several card indexes in different places has, however, already been pointed out. To avoid this danger, where it is necessary to have card indexes containing the same information, classified under various headings, it is usual to have one main card index where the cards contain all the details and notes which have been collected and where they are classified under the most important heading. The others, each classified under its own heading, contain only cross references to the main index, where full information is to be found. Thus, if the main index is arranged alphabetically under the names of the customers, the subsidiary index, classifying them by the districts in which they are to be found, would have only the names of the customers on the cards for each district and the main index would have to be consulted for full information about them.

Before concluding this fundamental discussion on card indexes, it is perhaps necessary to remove any chance of a misunderstanding which may have been formed in the reader's mind in case anything has been said which may lead to the belief that the card index is to be considered as one of the universal panaceas for all difficulties in matters of organization. Much as the author has appreciated their usefulness in many instances, he has also found, in his practice, cases where he preferred the bound book. The organizer has always to keep in mind that he is dealing with things which should be adapted to the changing working conditions of business life; he must always remember that "circumstances alter cases."

List of Customers

This discussion on the card index was started by mentioning the list of customers which is essential to the outside representative or traveller. As has been explained, this list consists of cards giving names and addresses of customers or prospective customers arranged in the main index alphabetically with a cross-reference to their geographical location. This only gives the fundamental idea; if the card index is to have real value it is necessary that the contents of the card in the main index should show the latest information on the business connexion by means of a short extract of the correspondence with the customer in the form of subject headings. Not only must each live inquiry or quotation be noted on the cards, but any news or information about connexions with other firms, or about any circumstances which may give rise to inquiries in the future, must also be available. How elaborate this card index is made depends upon circumstances, but it would probably be useful to introduce some coloured card system. For instance, customers' names, addresses, and business might be put on cards of one colour, live inquiries on cards of a second colour, quotations outstanding on cards of a third colour, and so on. With such a list of customers it is possible to prepare the programme of a business journey very quickly; supported by such a card index a sudden call for a representative can be used for a visit or visits to nearby customers, as all the information can be obtained in a short time, maybe before the departure of the next train. It may even be sufficient in cases of great urgency, to hand over to the representative the cards of the district in question for him to study during the journey, although it is obvious that this procedure should be limited to emergencies.

Reports from Representatives

The representative has to fulfil two main duties: he has to take care that his firm is always informed as exactly as possible about his present residence and his presumed movements during the next few days, so that urgent news can reach him quickly; and he must deliver a short but exhaustive report about each visit separately, which allows others to obtain a clear picture of the result of his negotiations. It is this second duty which is so often ignored, unfortunately not only from forgetfulness and indolence, but also from deliberate egotism. The representative hopes to become indispensable by accumulating knowledge, which he alone possesses, about certain business proceedings, but he forgets that he may be prevented by some contingency, such as illness, leave, or other business activity from dealing with the matter himself at the right moment. This may risk the loss of a valuable order, as in the absence of reports no one else has sufficient information to continue the negotiations with the customer. This situation can do irreparable damage to the reputation of a representative in the eyes of the management, who quite rightly are apt to regard secretiveness of this kind as a waste of their time and money, as well as being annoyed by the loss of the order.

On the whole there is probably no principle which could be more strongly urged on an industrial employee than that the interests of the affairs in which he is engaged come first before any question of personal prestige. When considering this problem exaggeration should be avoided and it would be a mistake to take the attitude that business is all-important, and the man who engages in it of no importance at all. This may express the attitude of some members of the management, who have no understanding of the social spirit of the present time; but the author must conclude from his long experience as an industrial employee that much more frequently it is the insistence on personal prestige which hinders gifted and efficient people from receiving the promotion in their careers which they would deserve if it were possible to take into account only their intellectual capacity. It is very often a defect of character, such as the secretiveness originating from egotism just mentioned, which makes it impossible to promote them to a higher managerial position. Apart from any unpleasant suggestion of personal favouritism, it can be said that the industrial employee in a lower position can draw the attention of his superior to himself only by real efficiency, if he wishes for promotion. As soon, however, as he has obtained a higher position, he fills it well only if he takes care of the education of a suitable representative and successor. The unfortunately widely-spread anxiety about maintaining a superior economic position, which keeps the employee back from the fulfilment of this duty, is a proof that self-confidence is lacking in the superior and a sign that something is wrong in the department which he is supposed to control. Where these conditions are found the higher management should look into the matter with special care, as it will have a very serious effect upon the efficiency of the subordinates.

These considerations justify us in drawing the conclusion that it is very much in the interest of the representative to deliver the necessary reports punctually and completely. If he has to deal with a management that understands its business, he can be sure that it will leave the business he has started in his hands as long as possible, if for no other reason than that the customer does not like to change from a capable negotiator.

All that has been said up till now on this subject of selling relates to the "home" or "head" office; but just this last consideration regarding the change of negotiator has made it necessary, or at least contributed to the decision, to use branch selling offices or agencies to cover adequately even the home territory, and more so to exploit overseas territory with any pretence to thoroughness.

The Branch Selling Office

The above-mentioned idea of securing a close connexion between the representative of the firm and the customers is in many cases the reason for allocating a certain district to a certain representative, and then, as soon as the business is too large or for some reason or other cannot be covered by a single representative, dividing his district into various parts and developing a branch selling office which works under the Head Office with a manager, usually the representative who was formerly travelling in the district. It must, however, be expressly pointed out that care should be taken to build up such an office only if there is a certainty that it can be justified economically. Only too often such branch offices have been opened merely because it was a fashion to have quite a number of them. Such branches, on coming into existence, tried to obtain as large an output as possible, the cost being paid by the parent firm and no profit being expected from the branch for the first year or two; the result was to increase competition as a result of which the goods had to be sold at ruinous prices. The decision to close down a branch which has been shown to be unprofitable is not an easy one to take, as such a procedure is rightly considered damaging to the reputation of the firm. There is therefore a tendency to hesitate too long before taking this step, and the opening without sufficient consideration of such branch offices has too often resulted eventually in the ruin of formerly flourishing concerns.

Without going further into the arrangement and organization of these branch offices, it may be mentioned that considerable reductions in the costs of branch offices have sometimes been achieved by co-operation between various firms in different branches of industry, which together open one such office. This usually appears as an independent firm under the name of the manager or managers. It differs from the completely independent engineering office by the fact, as everybody knows and can see from the advertisements, that it deals only with the products of the firms who have started it. This system can be especially recommended for overseas markets.

The Independent Selling Company

Another way of organizing distribution is by the formation of an independent selling company, usually in the form of a subsidiary company created by a parent firm which is then reduced to a pure production works. The necessary capital for the sub-company is provided either by the parent firm or in conjunction with outside circles interested in the new selling organization. What is happening here is only a logical development of the idea, explained in the Introduction, of the two pillars of an industrial concern—the production of goods and their sale. A special advantage of this development has been considered to be the sharp separation of responsibility brought about in this way which allows the chief members of the staff of each section to specialize and therefore to obtain greater success. It has also been pointed out—and certainly with truth—that the special work of the salesman on the one hand and of the administrator on the other call for quite different personal qualities, which are only rarely united in one and the same personality. It should, however, not be overlooked that this separation carried to extremes may also have counterbalancing disadvantages. For instance, it may easily happen that the salesman loses the intimate knowledge of the construction and working details of the goods he has to sell, and thus falls behind his competitors. There is further the danger that the whole intercourse between sales and production may become complicated and cumbersome and that in consequence the administrative costs may increase.

The survey and control of the work in the various parts of the concern can be obtained by accountancy and costing with sufficient accuracy and without increasing, by an actual division into two different undertakings, the unfortunate opposition between production and sales which so often exists. As nearly always in economic problems, advantages and disadvantages are *vis-à-vis* to each other and nothing can be done on fixed principles. The only solution is to consider each case on its merits and weigh up the pros and cons before coming to any final decision.

Sometimes the best solution may be the formation of a single sales company by several firms on a co-operative basis in a similar way to that described for a combined branch office. A number of firms whose production programme can be considered more or less supplementary to each other keep their production side separate but join their sales offices in one common sales organization; e.g. four models of motor cars and lorries are built in four different factories, various accessories for automobiles are produced in two other factories, but all six deliver their products to one sales organization, in which the production firms participate according to their turnover or on any other basis fixed by the contract between the various concerns engaged.

The Income of the External Employees

If we use the expression external employee for all those people who are employed outside the above-mentioned head offices and whose chief business is the acquisition of customers, we find a great variety of systems for remunerating them, not only from concern to concern, but also within one and the same undertaking. Usually the system varies with their position, whether they are called technical representative, manager, traveller, etc. Some are employees with a fixed monthly salary, who receive only additional travelling expenses; others are paid a commission on their sales in addition to their salary; sometimes this commission is the only compensation for their services. The commission system is undoubtedly a very great incentive to sales activity, but it is as well to decrease the percentage of the commission if the usual selling price cannot be obtained; in this way it is possible to put a stop to the activities of the commission-hunter who is only too readily persuaded to neglect the interests of the firm in the pursuit of his own profit.

With regard to allowances for travelling expenses, many different systems are in use. Some firms ask for very accurate statements of all expenses and repay them without any compensation for the inconveniences, such as the greater wear on clothes, increased laundry bills, etc., due to travelling. This way of paying travelling expenses is rare, or is usual only in the form of "confidential expenses" in the case of important members of the staff, who are not expected to explain in detail the expenses for which they ask compensation and where it is taken for granted that the expenses as put down include a proportion as compensation for the inconvenience of travelling. Some firms pay for each day of the journey a fixed allowance which is considered to be sufficient to cover all expenditure, including fares and all other special expenses; others again pay fixed allowances per day exclusive of fares and certain other costs for which only the exact amount expended can be claimed. These last two kinds of compensation for travelling expenditure have proved best in the case of employees with fixed salaries. By living within the daily allowance it is possible for the employee to save a sum of money to compensate him for the inconvenience and wear and tear of his journeys.

The Independent Representative

In some cases the representative receives no compensation at all for a journey. His commission has to cover all his income and expenses. In this case the traveller is no longer a real employee of the firm, but a more or less independent representative who does not receive a fixed salary but takes the commodity "on commission" and is to be considered as an agent, who buys and sells the goods in question. This kind of representative is very popular in industry and it cannot be denied that considerable success *can* be obtained in this way. On the other side it should not be overlooked that the independence of this kind of representative contains a danger, as the loosening of connexion between him and the firm is comparatively easy and the management is not able to exercise the same control of the representative to make him work to instructions as in the case of an employee with a fixed salary. In any case it seems to be particularly important to put down the mutual rights and duties of the representative and the firm in a written contract and especially to impose on the representative the obligation of reporting carefully on any individual business, and each new connexion, etc. Experience has shown that otherwise the management may too easily lose control of the business in the district concerned and may one day find itself unable to resist any unjustified demands of the representative.

The Confidential Representative or Agent

Besides the open representative there are in industry a large number of representatives or agents whose positions and activities are rather ill-defined and about whom very different opinions exist. They are mostly occasional connexions, rarely under any agreement as to length of service or area of district, and the activity of the agent is generally limited to obtaining inquiries. He does not usually negotiate the details of the business and he does not as a rule make it known that he receives a commission from the manufacturing firm. This system is probably more common in other countries than in England but there are some who declare that they have found the use of this type of agent satisfactory. There is undoubtedly, however, the danger of abuses; the agent may be working simultaneously for several firms who are each other's competitors and be disclosing business negotiations and prices. The work of the Sales Department with numerous representatives of this kind is comparatively large, as only in rare cases does the district of such an agent cover a fixed area. All these are disadvantages that cannot be overlooked, and will generally limit the use of the arrangement under discussion, but it will seldom be possible to get on without these people. A careful supervision in these cases cannot be too strongly recommended.

Conferences of External Representatives

It is obvious, and is only mentioned here for the sake of completeness, that all these "external" executives will be only occasionally in the main Sales Head Office, say, for reporting or in order not to lose personal contact with the sales manager, who is responsible for and should keep the direction of the sales policy firmly in his hands. In large firms, however, an arrangement which has proved very useful is an annual or biannual conference of the external representatives, although there is no question that the cost of these conferences is considerable. They are used to make known to the representatives and agents any new developments in the design and construction of the products of the firm, experience in the use of the products, change in the taste of the customers, or the progress of competitors. The representatives have the opportunity to criticize the suggestions and proposals that have come from the firm and to submit their own propositions, not only to the Head Office, but also to their colleagues who are responsible for the business in other districts. The success of these conferences depends largely on their organization and on the spirit which the sales manager is able to instil into the meeting and discussions. It should not be forgotten that some social gathering connected with these conferences will generally contribute largely to their success. These conferences are very often the only opportunity for colleagues who have to do the same kind of work in the same firm, but in different districts, to discuss with each other in a free and easy way the difficulties they have to overcome in their work.

The work which has to be done by the employees in the Sales Head Office will be explained later. Generally these employees are clerks engaged in administrative jobs.

CHAPTER IV

THE ESTIMATING DEPARTMENT

THE direct consequence of the work of the external employee is an estimate, where this is necessary. The first approach has been successful and the customer has agreed that a special agreement for the supply of a plant, adapted to the working conditions in his factory, should be prepared. The report of the technical representative has arrived and gives information about all the circumstances which may influence the appearance of the plant, the choice of size, the type of machine, and so on. Now it is necessary to make a suitable project and to provide an acceptable and profitable estimate.

Of course in many cases this is a very simple matter, e.g. when it is only a question of the sale of machines, apparatus, instruments, etc., that have been produced in mass or in large batches without customers' orders, and have been put in store in order to be able to cover immediately any demand. In the case of such products, which like objects of daily use are sold, so to speak, "over the counter," a proposal with an estimate is no longer necessary; the technical representative is so well instructed about their qualities by the information he has received from the Head Office by word of mouth, letter, or printed advertisements and price-lists, that he can himself choose a suitable product without any reference to Head Office, answer all the customer's questions, and make a definite agreement. In other cases, as will be explained soon in detail, however well informed the representative may be, it is still necessary to refer the customer's inquiry to Head Office, since technical and commercial considerations arise, so that only the specialized departments of the firm are able to do this work, basing it on their records, drawings, calculations, and experience. With regard to the large variety of industrial products it will be easily understood that all possible cases between these two extremes occur in practice. Naturally the tendency is always to approach more and more closely the case of the standard article kept in stock, where the costs of the preparatory work on each article sold are as low as possible and the costs of producing them can also be kept low. Apart from the fact, however, that working into store may involve a risk of loss and requires a considerable investment of production capital, many products, by their very nature, do not allow that degree of standardization which is essential with this kind of production. In order to avoid any possibility of misunderstanding, it may be added that this remark does not imply fundamental opposition to standardization; there will be sufficient opportunity later on to come back to this problem in detail.

For the following discussion it will be presumed that it is a case where a close study of all the details of the working conditions is necessary before an economically working plant which satisfies the customer completely can be delivered. It will be clear from what follows how far the method described can be simplified and costs decreased as soon as the working conditions become less complicated.

The Proposal

Usually, at least in works of a fair size, a special Projects Office is devoted to this kind of work. Commonly it is part of, or is at least closely connected with, the Design Department, which has to be discussed later on in more detail. This may be considered a very suitable arrangement ensuring that in the projects will be made no propositions which past experience has proved to be unsatisfactory in performance. Also it ensures that the latest, as well as any standard, design is taken into consideration, and that the best use is made of machines and apparatus already in store. About these matters the Design Department will certainly be exactly informed and therefore unnecessary costs can be avoided and all possible advantages gained by repeating already tested constructions.

When laying out a plant the first important job to be done is to determine the dimensions. This task can be of great consequence, according to whether the inquiry states with some degree of precision the results required, working conditions, efficiencies, etc., or whether some or all of this information is vague and has to be determined or guessed at from past experience of similar plants. This lack of data may be due to the customer's own lack of knowledge of what he wants and it may be beyond the power of the representative to find out. For example, if plants for the condensation of steam are required, the job is comparatively simple if the customer asks for a plant which is able to condense a certain amount of steam at a certain temperature and pressure. The task is more difficult if the only information is that a number of steam engines of given dimensions are working a certain number of hours daily under a given boiler pressure and that the plant to be delivered should be able to condense the quantity of steam they consume, as well as to produce a specified degree of vacuum. The work becomes still more difficult if the customer asks if the quantity of exhaust steam from his plant, say a colliery or an iron and steel works, with a number of different steam engines, is able to drive an exhaust steam turbine. In this case tests and surveys may have to be made on site, and may go on for weeks before the calculation and details of the exhaust steam plant can start. A further complication may arise, and the contractor's risk be increased, if the conditions of contract include a clause making a part of the payment for the new plant dependent upon results, for instance on the amount of electricity produced.

The Text of the Estimate

When the full particulars are known, it is necessary for the contractor to put his proposals and prices before the customer in such a way that all the essentials are clearly stated. This is usually done in the form of an estimate, tender, or quotation (the three terms have, for all practical purposes, the same meaning). The estimate must give not only full details of the plant to be supplied but also full information about the quantities in which deliveries are to be made and the amount of time they will take. General terms, governing deliveries, payments, and guarantees, and the events which may cause them to be varied, must be included. Above all, the estimate must make perfectly clear what work is included in the prices and where the supplier's liability ends. This can be done by the use of a number of accepted commercial terms and abbreviations which are in common use. "Ex-works" means that the customer has to pay all freight, etc., from the suppliers's door; "f.o.r." (free on rail), that the goods are loaded on to rail wagons at the nearest station to the supplier, the customer paying for the rest of the journey; or the prices can be quoted as covering "for delivery to site" when the supplier has to deliver to the customer's premises, the customer having to unload the goods. For export, prices may be quoted as "free on board ship" (f.o.b.) at port of exit, or prices may include the cost, insurance and freight (c.i.f.) to port of entry. This last will not include the charges at port of entry or for any customs duties, etc. Then again, if delivery is to site in a foreign country it must be clearly stated whether customs duties are covered and provision must be made for any unexpected change in these by suitable covering clauses.

If erection on site is included in the prices a fresh set of conditions arises. It must be stated whether or not such work as foundations, alterations to customer's buildings, electric wiring, connexions to customer's drains, hydraulic or air piping and so on, is included.

The estimate must also state the class of labour the contractor will supply, whether foreman only, all skilled labour, or all labour skilled and unskilled, and whether the customer has or has not to supply any lifting tackle or scaffolding, etc. Such other items—and there are many—as painting on site, packing and whether this is charged separately or to be refunded if returned in good order, all have to be included in the estimate. Many firms use printed conditions to cover all or most of these points.

After two world wars have made it clear how widely currencies can fluctuate and what this means for business life, it is probably not necessary to point expressly to the importance of fixing conditions of payment; but attention may be drawn to the point that if goods are produced to customer's orders it often cannot be considered as unfair to demand that the customer should do his share of the financing and not leave it to the supplier alone. This is of especial importance in very large contracts, such as those for gasworks and waterworks, electric power stations and ships, the building of which may take months and even years.

The Prices in the Estimates

In putting the prices into the prepared text of the estimate, the first and most important consideration is to base these prices on the costs of the product in question. This seems obvious, but those who have experience know that it is necessary to stress this point as emphatically as possible. For it is frequently impossible to determine the exact costs in advance, or even to estimate them approximately; and unfortunately the not uncommon result is that not only is the correct method ignored but an attempt is made to find out the prices of a competitor and to undercut them to an extent which seems just enough to obtain the order. It is unnecessary to explain in detail the dangers connected with this procedure. How a calculation is possible, or at least how an estimation of the costs can be carried out as correctly as possible, will not be discussed at this point. This problem will be dealt with later on when all the fundamentals have been discussed. At present it may be assumed that the costs of the object in question are known. To work out the selling price when equipped with this knowledge is a matter of pure price-policy, i.e. the determination of the margin between costs and selling price which, to avoid risk to the firm, should be as large as possible, yet should not be so large as to lose the business.

Of course *experience* is in this case of great importance and valuable lessons will certainly be learnt if an apparently certain order *is lost by making this margin too great, or, conversely, by finding* out after a contract has been placed that an "exaggerated modesty" has made the gap between one's own prices and those of competitors too large; but a greater asset is the *sense* or *feeling* which is developed for these problems. This feeling for the correct fixing of selling prices, which some acquire more quickly and better than others, has been considered in some firms as a characteristic of a good salesman, and, in consequence, the fixing of the selling price is left to a group of employees with a purely commercial education. In this case the work of the technical calculator stops with the fixing or estimating of the costs, and relying on these figures another, who has no detailed insight into the production of the machine or plant in question, inserts the selling prices into the estimates. It is the author's experience that this division of labour is absolutely incorrect. This opinion is not the result of underestimating the value of commercial activity; on the contrary, there cannot be any question that this fixing of the selling price on the basis of the cost demands quite important commercial faculties; but by eliminating the technically educated intelligence a lot of advantages are given up quite unnecessarily. Only a person who is completely familiar with the calculation or estimating of the costs is capable of making a correct judgment where advantages over competitors may exist if special arrangements in the factory for increasing production can be made, or where, on the other hand, workshops in the course of a major transformation or in a somewhat obsolete state must be considered as a drawback, as their comparatively high costs will make the final product too expensive if the usual margin between costs and selling price is maintained. Only such a man can judge how a change in output, say an increase in consequence of the order under discussion, may influence the costs, etc. His co-operation will therefore help to prevent the mechanical formation of prices which do not take into account the actual conditions existing in the undertaking. The person who has only commercial experience unassisted by technical advice can work only on averages based on past history, and cannot make the rapid changes in the margin between costs and selling price to take account of changes for the better or worse in the production position. It is therefore more commendable to leave the whole development of selling prices to one person, if possible technically educated, who should of course be at the same time an efficient business man. That such a combination of different faculties in one and the same personality is possible has fortunately not to be proved to anybody who knows something of the history of industry. On the other hand, really valuable personalities of this kind are not easily found, and this is a further reason for a young engineer who feels that he has the necessary qualities to devote himself to this important branch of his profession.

Although it may be considered a repetition of what has already been said, and although it has to be dealt with later on for a third time, this matter should not be closed without the following reference: apart from the sale of monopoly articles, it is not possible to use in the estimate without further consideration the prices calculated in the manner explained above. The market which has grown up for the product in question by the operation of supply and demand is to a large extent decisive. It would, however, be wrong to give up estimating the costs because of the great influence of the market on the price, since this would mean taking a risk without any justification.

Enclosures with the Estimate

As soon as the estimate is completed it is only necessary to write an accompanying letter and to send both with drawings, printed matter, etc., to the customer. It is obvious that the representative, the traveller, or the branch office, etc., who started the connexion and has to follow up the business, should receive a copy of the estimate, prices, and other documents which the Head Office sends to the customer. That the contents of all these documents should be objective and accurate does not need to be emphasized. There are other points, however, which should be taken care of, but which are unfortunately often overlooked.

There is, first of all, the wording of the letter, a matter which, until recently, has been almost entirely neglected. To-day, thanks to critical attacks from various quarters, a considerable improvement has taken place. The so-called commercial style, with its old-fashioned clichés and complicated sentences, is slowly disappearing, and the young man who enters a commercial department for the first time cannot be warned too often to avoid it. The commercial correspondent should write concisely, clearly and to the point; for the rest he should write the ordinary language of the educated man; a special commercial language is as bad as a special legal language. Professional or technical terms should be avoided unless it is certain that the reader will understand them in exactly the same sense as the writer. There is considerable confusion in their usage and it is time that steps were taken by the appropriate professional institutions to review the existing usages and, where necessary, make new terms, which should then be made standard practice by the British Standards Institution (B.S.I.).

The make-up of the letters, documents, etc., is also of some importance. First, attention should be drawn to the fact that much information which it is necessary for the customer to know about the supplier is usually to be found printed in the letter heading, for instance the correct office address, the telephone number, sometimes a banker's reference, etc. The letter should have a subject heading, perhaps having the prefix "re," which means "in respect of"—although "re" is nowadays often omitted as unnecessary. The heading is important for the orderly filing of the letters as far as possible under the same heading in both customer's and supplier's files. The date on which the letter is sent must be shown and reference should be made to the dates of any previous correspondence on the same subject; any reference letters or numbers there may be should also be quoted.

Finally it may be pointed out how expedient it is to keep related documents, printed matter, drawings, descriptions, etc., together in a suitable folder. Modern businesses should use only good-quality stationery and printed forms in order to present their products in a clear, attractive and dignified way. The good impression which can be produced on the customer in this way at comparatively low cost should not be underestimated.

Simplification of the Work Necessary for Working out Estimates

This description of the working out of an estimate shows that a considerable amount of work has to be done before such a job is completed. Taking as an example a company with a capital of £1,000,000 and a turnover of four times this capital, if it has to face the strong competition which is usual in many branches of industry, it is nothing extraordinary if only 10 per cent of the quotations sent out eventually become orders. In many branches the management would be happy if as high a result could be obtained. Supposing, however, that 10 per cent is the average for the whole concern, it would mean that quotations to a value of £40,000,000 are made every year. The enormous amount of work involved in preparing all these quotations at full length, work of which 90 per cent brings no return, will readily be realized. Up to now it has been the exception in most industries for estimates—even those which have caused a large amount of preparatory work—to be paid for by the prospective customer. It is therefore obvious that all possible means must be used to simplify the work of getting out quotations. Fortunately it is nearly always possible to economize. Most companies limit themselves to certain classes of business, each class being dealt with by a branch of the company that has its own speciality of machine or plant or of the application of one type of machine or plant to one set of working conditions. It is rare that something completely new has to be offered, and a considerable saving of time and money is made possible by collecting carefully details of all work that has already been done, keeping it clearly indexed, and referring to it either to use it again without alteration or to use it as a basis for a new adaptation to different working conditions.

In logical pursuance of this idea the two most useful expedients are: first, the use of *forms* for the estimates on which are printed or otherwise duplicated all that is of general application, such as conditions of delivery, payments, etc., but leaving free space for the text proper, or, as a further development, also containing the whole text, if offers of one and the same kind are made so often that it pays to do this.

The other expedient is the collection of prices in easily followed *tables*, their use having the additional advantage that mistakes can be more easily avoided. These tables which are prepared for use within the Estimating Department only, should show also the weights of the parts in question and the amount of profit included, the first in order to be able to calculate the cost of freight, the last in order to be always clear about the profit which can be expected when making an offer and what reduction can be permitted if required. For it is in itself good policy to sell the same goods to all people at the same price—there are persons who consider the rigid adherence to this principle to be an essential condition of honest business—but hard reality only too often plays havoc with what may be theoretically correct.

It is best for the calculated profit to be entered into these tables not as an amount but as a percentage, or as both, and in any case it should be expressed as a percentage of the selling price and not, as so often happens, as a percentage of the cost. This last usage is a very bad habit which only too easily leads to self-deception. What is of most interest to the management at the end of the year? No doubt the answer to the question: What is the profit in proportion to the turnover? In other words, here the management refers the profit to the turnover, and based on the experience of the past a feeling develops as to what percentage profit can be considered as an average for the branch of industry in question. Each single transaction in the course of a year will be compared with this figure and judged correspondingly. If in these price-tables the profit is expressed in per cent of the *cost* the two figures in question cannot be compared with each other, as something which costs £80 and is sold at £100 shows an addition of 25 per cent to the cost, but shows a profit of 20 per cent only on the selling price. This stupid mistake is unfortunately not infrequent in practice and has done much harm.

It not infrequently happens that a mistake which has crept in becomes so much a part of the regular pattern of routine that it is repeated again and again for years, and finally, when attention is drawn to it, puzzles everybody concerned to explain how it has arisen and why it has continued for so long. Calculation is detail work, and although it must be guided in all circumstances by a far-sighted leader, who must continuously observe that his policy is followed and adapted to changing conditions, he will concern himself with the details of calculation work only occasionally, as this is the job of his subordinates. In this way, a mistake which has once unfortunately crept in may be constantly repeated.

It is almost unnecessary to mention that the tabulation of prices is a very responsible job; an independent careful verification is therefore necessary. In some cases this can be considerably facilitated by a graphic method, e.g. by plotting the selling prices of machines of the same kind but of different size against these sizes and investigating whether the prices lie on a continuous curve. Sometimes it is even possible to avoid the determination of intermediate values by reading the prices on the curve; but great care is necessary when using this method for it gives correct values only when there are no abrupt changes, for example a difference of construction between one size and the next.

Price Leaflets for Customers

These price-tables form the basis of the price leaflets, which have been mentioned before; they are printed and usually posted to the customers, who can put them together to make a price-list of the products of the supplier's firm. In this way considerable relief is afforded the Estimating Department, the customer often ordering to price leaflet number "so and so" without asking for a quotation. Of course it is necessary to give a simple reference number or letter or both to the individual price leaflets, so that the customer can refer to them when ordering. Changes of price can be shown on supplementary leaflets and, when necessary, a whole sheet can be declared invalid and be replaced by a new one.

CHAPTER V

THE CORRESPONDENCE DEPARTMENT

Now that we have discussed the means of bringing into the works sufficient "nutrition" in the form of customers' orders, the next question to be answered is: What has to be done to prepare to carry out these orders? But first it seems appropriate to clarify the arrangements for intercourse in writing between the undertaking and the customers as well as between the suppliers, the Head Office and the branch offices and other external executives. This is mainly done by the Correspondence Department and by the Filing Department. Of course, the working of these arrangements is not finished when the customer's order is received, for the whole of the subsequent correspondence is done by these departments. Their work will be mentioned frequently in later chapters, and may therefore conveniently be treated in detail at this stage.

The Office Equipment

Only a few decades have passed since it was considered that even the most modest luxury should be kept out of rooms used as offices, even though numerous people had to pass a large part of their life there. All expedients to simplify the many mechanical activities in offices were lacking. Correspondence was often relegated to a small room, probably part of some store, which was badly lighted, untidy, and, even with the best intentions, impossible to keep orderly and clean. How could our modern factories and giant business undertakings carry on to-day with such arrangements, which would greatly hamper them, in their competitive struggle? And yet, how many of these remnants of the past are still in use in modern business plants! They are there because "it would be too expensive to change them to accord with modern ideas." It is certainly true that a considerable investment of capital may be necessary; but it should not be overlooked that without modern equipment the working expenses will certainly be considerably higher as all experience has proved, and it is in the long run undoubtedly cheaper to have a reasonably modern office. In order to avoid any misunderstanding it may be expressly pointed out that the writer is not pleading for any luxury in the office that is incompatible with sound business principles. What is recommended is light, lofty and healthy rooms with good heating and ventilating equipment, with practical and friendly furniture which gives some comfort to the employee during his stay in his place of work—i.e. from a quarter to a third of his life-time. Persian carpets, crystal lustres, and leather easy-chairs are, however, extravagances that are not recommended; they are mentioned only because experience has shown that even these exaggerations can be found, where the first intention was only social progress and to increase the employee's capacity for and pleasure in work.

Details of these arrangements, such as the most suitable furniture, writing-desks, stands or filing cabinets, writing materials, stationery, etc., will not be dealt with here, as they can be obtained from any firm specializing in this type of equipment. It is, admittedly, not always easy to find out which of the articles offered is the most suitable. Without in any way doubting the correctness of the ideas which, in adaptation of Taylor's views, have influenced the design of office equipment, one should, however, beware of an over-estimation of its possible success; it is clear that to facilitate and shorten the more mechanical and repetitive forms of office work saves time and money, that to fix exactly where each implement can be found and to keep it there relieves the brain from the unessential, and makes mistakes more easily avoidable; but on the other hand it is a fact that time can be wasted on even the most modern desks, and considerable confusion can also prevail in filing cabinets built to conform to the latest psychological ideas. Of course these remarks should not be taken to mean that these matters should not be taken into consideration when new office furniture has to be bought. It is necessary to mention in passing how much the standardization of the size of paper can influence the type of office furniture, and there will later on be an opportunity to come back to this problem in more detail.

It should, however, never be forgotten, that success in business depends in the first place on the spirit in the office, and on this spirit the manager has by far the greatest influence. If he understands how to get the best out of his subordinates without becoming fussy, if he himself keeps order on his desk and in his filing cabinet, if he knows how to correct mistakes and to check untidiness firmly, yet with understanding and a sense of proportion, it is nearly always of greater advantage for the whole than the best technical arrangement the office can produce.

We may here consider an important problem which at each new building or each change of offices is nearly always a subject of lively discussion, without any general conclusion ever being reached. Is it better to arrange a few, very large rooms, each for a considerable number of employees, or several small rooms each for only a few persons, or even a single room for each individual?

All these kinds of offices have their advantages: the first is especially easy to supervise, the last is almost essential to the individual who has to concentrate. Thus generally the principle may be laid down that the more difficult the work which has to be done by the employee the more it is necessary to let him work with few other persons, or preferably entirely alone in one room. It must be pointed out, however, that in quite large and acoustically well-built rooms, the noise caused by people writing or drawing in them does not rise to unreasonable levels, and most people quickly get accustomed to it; but in a room with twenty to twenty-five typists, the noise may lead to nervous trouble in some cases, and will certainly impair the total efficiency. On the other hand, the author remembers a completely new office, built for a factory, where each typist had her separate small room. The management declared that a considerable increase in output was obtained by this arrangement. The opinion of the typists was not unanimous on this point, and it is certainly a question which would be answered differently by different individuals. The experience of the author as employee as well as manager is that the idea of making use of a few large rooms, each with a large number of employees, should not be insisted on except for the purpose of facilitating supervision.

The Sorting of the Mail

An attempt will now be made to explain the use of all the equipment at work in a modern office by following what happens to letters received and sent out. The mail has just arrived early in the morning. It is opened by an employee considered by the management to be careful and discreet. Perhaps the employee will utilize one implement which cuts the envelope and another that stamps the letters with successive numbers and the date of arrival, sometimes even with the exact time, hour and minute, when it is opened. Then the letters are entered in a journal[1] in strict numerical order with the sender's name, date of letter and a short remark indicating the contents of the letter. Often other references are put on the letter and papers, which are also repeated in the journal, indicating the department, or departments, to which the letter has to be sent for reply. In small or medium works the whole mail will remain where it is for the management to read it carefully. In larger undertakings, where the management has to be relieved of detail work as much as possible, the procedure described is to-day often changed, the letter journal no longer consisting of a bound book but the entering being done on loose leaves with the typewriter, so that it is possible to obtain several copies by means of carbon paper. Each member of the management receives one copy and each employee who has the duty of answering letters is obliged to show every important letter to the member of the management to whose function the letter belongs; the manager can be certain from his copy of the journal or letter-list, that he sees what is really important. The loose leaves of the journal are collected in a folder and sent to the Filing Department, who can then make certain that all letters received are eventually sent to them for filing, and this procedure enables them to trace the answers.

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[1] A book in which events are entered in order of date, without comment, just as they happen, as a rule also without reference to past and future events. As the name implies, the entries are usually of daily occurrence, but they can be weekly, monthly, or for any other period.

It is often disputed who shall write the final answer to the letters. Is it better to let the person who has the professional knowledge write the reply, or should it be done by some other employee, often called a "correspondent," who has of necessity to get the required information from others? Again the special conditions of the undertaking, especially its size and extension, will influence the decision. A correspondent can be recommended only for large concerns, where he has the advantage of obviating the possibility that contradictory letters from different departments may be sent to the same customer. Besides, the correspondent, because of his greater experience, will be able to write letters in much better style and in considerably shorter time than somebody who writes letters only occasionally.

The letter journal as described is used in many concerns. It has proved useful and the managements would resist any suggestion that it should be abolished, although they would agree that considerable work is involved in keeping it properly and especially in following up letters entering the concern until they are filed by the Filing Department. The argument against giving up the letter journal is that without it the management cannot ensure that important letters are answered at the right time, and that—from indolence or even from malevolence—they can be lost, when the possible damage and the impossibility of calling the culprit to account could be much more serious than the cost of keeping the letter journal. Their objections are certainly justified and yet it is a fact that there are large and well-organized works where such a journal has not been kept for many years and where no difficulties worth mentioning have happened as a result. It is more or less a matter of taste or temperament how far to go with such measures, which can be considered as pure measures of control. It also sometimes comes about that the whole working conditions are so changed in the course of time that what was absolutely necessary in the past has become superfluous, or vice versa. For this reason details of organization of this kind should be reviewed from time to time.

Shorthand and Typewriting

Nowadays commercial letters are rarely written by hand; they are dictated to a shorthand-typist, who will either take them down directly on a typewriter or will take them in shorthand to be typed out later. Dictating is an art which is generally learned in a short time, especially if the second method, shorthand dictation, is used; the method of dictating direct on to the machine certainly needs more practice. Only in the case of very important letters will the correspondent find it necessary to write out the letter by hand, in the form of a rough copy which has to be typed only when it is considered completely satisfactory.

Occasionally also a *dictating machine* is used, the main part of which is a phonograph. It is claimed that a considerable saving can be obtained by the use of this instrument, as the correspondent can dictate his letters at any time convenient to him, even outside business hours when no stenographer is available, and that the typist can do more work since the pauses caused by interruption in dictating are eliminated. It has been the author's experience that some otherwise satisfactory typists have been unable to work with these machines, but perhaps this is a difficulty which only rarely affects the younger generation of typists who take such machines for granted.

To say much about *typewriters* would be superfluous, for they are too well known to everybody. They are made in various sizes, depending on the size of paper used. All modern machines, except the smallest portables, are fitted with a tabulator which is used for the typing of forms with vertical columns. Typewriters for typing in bound books are available. For the rest it can only be recommended that one and the same make of typewriter should be used as far as possible throughout the works. This facilitates the maintenance of the machines, the stocking of spare parts, of ribbons, etc., as well as the type of forms used, since this may depend partly on the kind of typewriter.

The Telephone

One of the most important installations in the modern office is the telephone, without which modern business life would be impossible. Its two main uses are as a connexion between the different departments and shops of one and the same works and as a connexion between the works, the office, and the outer world. In the second case the telephone is also used for the receipt and delivery of telegrams, for which the teleprinter can also be used. This is an apparatus similar to a typewriter, easily used, printing the message simultaneously at the transmitting and receiving stations, which may be the main and a branch office of the firm.

Calculating Machines

Finally it may be as well to mention the calculating machines of various kinds, which are now almost as familiar as typewriters. So far as pure calculating work is concerned they are used chiefly in the Cashier's Department, and for book-keeping, statistics, etc. In the Correspondence Department calculating machines are applied usually in the form of the "calculating typewriter." This is a typewriter which can add horizontal and vertical columns of figures whilst they are being typed out. There exist various models of these machines, some like the usual typewriter, where the paper is introduced in loose leaves and rolled round a cylinder, others like a "book typewriter" where the paper is laid on a table like a book and the whole typewriter moves over the flat paper. The latter type is especially used in the book-keeping department, where the strong tendency to roll acquired by the paper after passing round the cylinder is a nuisance when the paper is required flat for further operations.

For many tasks the calculating machine cannot be replaced by the slide rule, so familiar to every engineer. As soon as, for example, payments of money have to be determined, the ten-inch slide rule, which is indispensable for most kinds of technical calculations, is not accurate enough. Attempts to increase its accuracy by increasing its length very soon make the instrument unwieldy. The extra length can be obtained by rolling the scales round a cylinder like the thread of a screw, the scales being moved relatively to each other by a rotating instead of a sliding movement; but although there is no doubt that in this form the accuracy would be great enough even for commercial calculations, experiments in practice have not always been very successful, probably because the staff in the offices in question are not accustomed to the use of such instruments, and their superintendents not being familiar with the principles behind the instruments are not easily convinced of its suitability. The introduction of a novelty is always difficult, and if there is not somebody with sufficient enthusiasm to overcome the initial resistance the method or idea very often has to be abandoned.

The Dispatch of the Mail

The letters to be signed are put into blotter-pads, books formed by leaves of blotting paper, with large holes in them, so that no letter between these leaves can be overlooked. Envelopes with the correct address, the same as those on the letters themselves, are also enclosed and should be checked twice, so that no mistake can happen. Experience has shown, however, that errors cannot be avoided completely and, since each single mistake can easily lead to considerable inconveniences, envelopes having a part of the front transparent to allow the address on the letter itself to be read are sometimes used. It is very necessary to take great care to fold these letters to ensure that the whole address is fully visible and that the letters cannot move inside the envelope so that the address is no longer opposite the transparent part. In large works, where there is a very considerable post, special folding machines are used for this job. A list of enclosures should either be typed on the letter or on a separate slip or label attached to the letter by gum. This is particularly important when the enclosures are too large to go into the blotter-pads.

As the postage may add up to large amounts in the case of an extensive correspondence, a careful check on the cash is necessary. This is usually done by dividing the job between two employees, usually juniors; one finds out what stamps are needed for the contents of the blotter-pads, the other buys the stamps and keeps an account of his transactions. Nevertheless occasional inspections of this cash are advisable, to remove any temptation which may be offered by the difficulty of checking it. A great facilitation of this control and a considerable decrease in the work can be achieved by using stamping machines which print the value of the stamp on the envelope. They are installed by the Post Office and their introduction can be recommended.

Copies of Outgoing Letters

It is the duty of a conscientious business man to keep copies of his outgoing letters and to keep them, together with the letters received, in good order after they have been answered, so that the whole *course of the business can be reconstructed from this correspondence.*

The necessity of keeping copies of outgoing letters is fulfilled in modern works in two different ways. The first is to take carbon copies of the letters when they are being typed. A reasonable number of readable copies—in some cases up to twelve—can be obtained in this way. A disadvantage is that all corrections in the original letter must be made also on the copy or copies, and erasures made whilst the letter is in the typewriter can easily lead to illegible words in the copy. In addition there will be no signatures on the copies. It is, of course, possible to avoid this last defect by signing the copies, but this means an increase of routine work to the person or persons who are the highest paid in the concern. It is sometimes said that having no signatures on the copies is without importance. The author must agree that he cannot remember a case where the authenticity of a copy has been doubted for this reason, but it must also be remembered that, especially in larger works where a number of people sign the letters, for internal reasons it is frequently of value to know who has signed a certain letter. This is usually done by adding the initials of the person signing to the reference number of the letter.

The second method is to type the letters with a special copying ribbon in the machine. The simple screw press and the bound letter-copy book which were formerly used have long since been replaced by roll-copying machines, in which a roll of thin paper is moistened and pressed by a hand-driven roller against the letter to be copied. A further development of these machines is an automatic cutter for the copying paper, an electric drying arrangement, and an electric drive replacing the hand drive. By means of these modern machines the copying work becomes quite easy and independent of the skill of the person who is doing this job. Thus some disadvantages connected with this second method have now been overcome. Others, however, cannot be avoided. The copying ribbon in the typewriter is the cause of some inconvenience. The preparation of the mail, which is the last work of the business day and has to be done by a definite time to catch the post, takes more time, and the production of enough copies of the letters—and several copies of each letter are frequently needed—is not always possible in the time available, so that carbon copies have to be taken as well. Thus it is a matter of opinion which of the two methods is preferable; but it is probably correct to say that at present the taking of carbon copies is more generally favoured.

In some firms the copies are not sent immediately to the Filing

Department, but are first put into circulating folders according to the subjects with which the letters deal. These folders make the round the next day to those persons for whom they are of interest; but it happens only too often that somebody cannot find time to read these folders and keeps them back. This means that the files will not contain the latest information and mistakes in further correspondence are only too likely to occur. A special copy is therefore often made for these circulating folders only, which can be destroyed when it is finished with. Apart from the fact that this expedient is expensive for the purpose it has to serve, the copies of the letters in the files will not then show who has read them and the most important advantage to be obtained by the use of these folders will therefore be lost.

It follows that it does not do to rely too much on these arrangements: the copies should be sent immediately from the place where the mail has been dealt with to the Filing Department, and there put into the files as quickly as possible. Anyone who wants to know about anything referred to in these files, in order to be able to do his own work correctly, has to study the files. Of course it must be admitted that this assumes employees who are to some extent working independently and are ready to take responsibility. It may be a special advantage of this simpler and therefore cheaper organization that it demands more of all who have to write letters and trains them to take a more intelligent interest in the business.

Methods of Copying

Sometimes it is desirable to have more copies of a letter or any other document than can be obtained with a typewriter, i.e. more than a maximum of ten or twelve copies. In this case one of the many types of duplicating machines is used. The choice of the system is generally determined by the number of copies needed and the quality of the copying required.

First may be mentioned the methods based on chemical processes similar to transfer pictures, such as copying by the *gelatine process*, or *hectographing*, and the better *opalographing*. The next higher steps are the wax-paper copiers, the best known representative of which is perhaps the *mimeograph*, which uses a stencil produced in wax-paper on the typewriter through which ink is rubbed on the sheet of note-paper by means of a roll. There are also the *plate-black press*, the plate of which is produced by a photo-chemical method, and the *lithographic* method, which is preferred if the quality of printing is of special importance. The next group contains numerous variants of the *planographic type printer*, the manipulating of which is, however, not quite so simple and takes up rather a lot of time. Nearly related to these, but considerably more efficient, are the *rotary type printers* which are made with hand or electric drive. Both these are very similar to the printing method proper and one of them will no doubt be chosen if editions of, say, a thousand or more copies are needed.

As is evident from this enumeration the transition from carbon copies on the typewriter to the printing press is quite gradual. This last method will rarely be used by the firm but will mostly be done by a printer. It is, however, possible that the demand in the firm is so large that the building of a special "house printing office" would be economical. This problem has already been discussed earlier on and it is only necessary to add that when considering this matter, it should not be forgotten that in some cases, e.g. when printed forms are to be produced, it can be a great convenience not to have to negotiate with an outside firm, which is usually not so adaptable as a part of the firm itself would be, with regard to the exact kind of printing and layout and the time of delivery.

As a special variant of duplicating machines the *addressing machine* is worth mentioning. It allows a great number of addresses to be printed again and again on envelopes, as would be necessary if, for instance, letters, advertisements, leaflets, price lists, etc., have to be sent repeatedly to the same customers. For the rest these addressing machines have also been used for internal office work, e.g. for wages lists, for which they have been used with success in medium and large undertakings and have replaced the time-wasting methods of writing by hand or the book-typewriter. In the cases of addresses which are used very often, however, e.g. those of travelling agents, branch offices, etc., printed envelopes are preferred. They are scarcely more expensive than blank envelopes and ensure that the disadvantages of wrong or incomplete addresses are avoided.

CHAPTER VI

THE FILING DEPARTMENT

LETTERS received and answered as well as copies of letters sent out are, as already mentioned, collected in the Filing Department. They are kept there in folders in such a way that it is easy to find not only any writing, document, paper, publication, etc., which has been given to the Filing Department, but all other information concerning the same subject. If this is to be possible it depends, however, not only on accurate and rapid work by the Filing Department but also on the whole works' observing some rule of procedure when writing and answering letters. These rules must be drawn up with care to facilitate the difficult and responsible work of the Filing Department without being "fussy" or difficult to follow. One of the most important of these rules, which is unfortunately very often broken in practice, is that in each letter never more than one subject should be dealt with, and this subject should form the heading of the letter or be introduced in the first sentence. As already mentioned, the attention of representatives, travellers, and fitters at work on sites outside the factory, should be especially called to this point. Further, anyone who has answered a letter completely must indicate this on the letter answered, by either a note or an initial. The manager of the Filing Department should be expressly empowered to return any letters or other writings which do not conform to these rules, and to insist on the strict observation of the rules, if necessary making a complaint to the superintendent about the careless employee, and, if this produces no result, to the managing director.

Principles of Sorting and Filing Letters

It is impossible to answer generally the question as to what principles should be used in the Filing Department for sorting letters and documents. Sometimes it is best to take as a guide in filing the names of the customers, sometimes the subject dealt with in the letter, or the order number; but as soon as a decision has been made, it must be followed without exception. If the circumstances call for finding files or letters under other headings than those according to which the filing system has been built up, the means of finding the information can best be provided by card indexes built up under these headings, as explained earlier on.

Methods of Storage

Covers of stiff paper or cardboard, usually called folders or files, are used for keeping the letters. The folders are of different types and can either be kept with their backs uppermost in a drawer or can be arranged like books on a shelf. Again it is more or less a matter of taste which system is preferred. The letters and copies are punched so that they can be held in the folders by the metal or wire fasteners supplied with the folders. Usually the fastener hole is strengthened by sticking on a gummed cardboard or linen strip or ring, which may be put into position by the same machine that punches the holes.

Issuing of Files

It should be strictly forbidden for anyone but the manager of the Filing Department to take any documents whatsoever out of a file, for they may be legal documents the loss of which may mean considerable inconvenience. A note to this effect should be printed on the inside or outside of the front cover of the file and the strongest measures should be taken against anyone who disobeys it. It is also important that files should be issued to other departments of the works only against a signed receipt, which is surrendered as soon as the file is returned. The files should be returned normally by the evening of the same day that they are borrowed; if not, a special permit should be given to keep them longer. This rule is necessary to avoid their being left lying about uselessly in other offices. They should under no circumstances be taken out of the works without a special permit, and must not be locked in a drawer or writing desk by the borrower.

Work in the Filing Department

All letters, documents, etc., arriving in the Filing Department should go to the manager, who checks whether everything is in order. The entry in the letter-journal is then made where necessary, and everything that has been accepted is put into large blotter-cases, also called letter-distributors, in such order that the further distribution into the individual files can be done by comparatively untrained and therefore lower-paid staff. Naturally the manager has, even if only superficially, to take notice of the contents of the letters, etc., if only so that he can arrange for a letter which deals with more than one subject to be copied so that it is available for reference in more than one file. (This is undesirable but cannot be avoided completely.) The manager must read all the letters, moreover, as it is his responsibility to decide under what heading the letter must be filed and that it is done in logical order. It is obviously necessary that this manager should be a quick, intelligent, and discreet man, who has to be paid accordingly. If he is properly supported and the rules for taking care of letters and files are strictly enforced throughout the whole works, work in the Filing Department can be a pleasure and will not be, as is so often the case, a continuous source of trouble and bitterness. For nothing is more trying to nerves and temper than to find when an important decision has to be taken that the necessary particulars either cannot be obtained quickly or prove incomplete when they are eventually found.

Centralization or Decentralization of the Filing Department

A question which has been much discussed is whether all the files of an undertaking should be kept in one place or separately for each department; or whether centralization should extend only as far as departments which are working closely together. It is not surprising that this problem has not yet been solved, for it will probably never be possible to make one rule to suit every situation, and the answer to this question will differ with the kind and size of the undertaking concerned. In principle it can only be said that the smaller the works the greater the advantages of centralization in one place; it offers a better chance of keeping files up to date and in proper order under the right headings, and gives quick reference without danger that the disadvantages so easily connected with centralization will outgrow the advantages. The particular disadvantage of centralization is that a bureaucratic rather than an objective treatment is given to the work of the Filing Department, which eventually comes to regard itself and its work as an end, instead of as a means of assistance to all other departments—filing for the sake of filing and with no other objective. This problem is one not by any means confined to filing departments and it has to be taken into serious consideration. Men and departments too easily lose sight of the purpose of the job they are doing and, forgetting that the work they do is to further the interests of their community, their firm, or their family, use it instead selfishly to inflate the sense of their own importance.

PART II

DESIGN

CHAPTER VII

THE DRAWING OFFICE

THE efforts of the outside employees, the representative or the branch office, supported by the Estimating Department in the Head Office, have obtained from the customer an order in the way explained, the written confirmation has arrived, and now it is important for the order to be executed in the stated time according to specification, technically accurate, and as economically as possible, i.e. with the lowest possible cost.

Design and Production

In order to achieve this end it is necessary that from now on a single unifying mind must make itself felt, prescribing exactly how the goods in question or the individual parts of the machine, etc., should be developed. That this mind must be the mind of an engineer will not be seriously disputed by anybody. It is also obvious that this engineer must know how to think in terms of cost of production. But the question arises: How is this controlling mind to be selected? In almost every works of a certain size there are several leading men with engineering or technical education, and unfortunately it is not rare for rivalry to exist among them, each believing that the others are not entitled to give him any directions. Anyone who has been employed in several factories knows that there is only too often conflict between "production" and "design." This conflict is unintelligible and nonsensical to the objective observer with the interests of the whole concern in view, but it occurs too often for it to be ignored. Palliatives do not help; it is necessary to get this problem in correct perspective from the first.

What is the activity of the designer and draughtsman? It may be useful to analyse this activity into three steps; this does not mean that these steps can always be clearly distinguished in practice, but only that this division is a useful means of finding out what is really going on in the designer's mind consciously or subconsciously.

(1) The conception of an idea and finding the material expression for this idea.

(2) Laying down principles of size, shape, and materials which will allow the material expression of the idea to be achieved.

(3) Examining and modifying again and again the results of (2) above in order to reach the goal in the most economical way possible.

It is possible to say that in a sense these three steps are characteristic of the work of the original inventor, of the designer, and of the draughtsman respectively. The first step need not be discussed here; it is the province of the creative genius and will be welcomed wherever it can be found, without regard to person or position.

The second step is the proper field of the designer, where he rules more or less absolutely; for a knowledge of production arrangements, both of those existing as well as of those needing to be created, is the basis of constructive activity; where this knowledge, even if superficial, is missing, it is not possible to speak of a designer at all.

The third step represents the activity of the draughtsman. Here is needed such an insight into all the possibilities of production methods and into the action and efficiency of machine tools, such an accurate knowledge of what other work is in progress and of its running cost, in short such an intimate acquaintance with all the problems of the workshop, that the designer or draughtsman alone is not able to decide anything finally. The marks of a good draughtsman are an understanding of the problems arising in the workshops, a willingness to negotiate repeatedly with the people responsible for the preparation of the production or for the production itself, and honest attempts to meet their reasonable demands made in the interest of profitableness. Too often the arrogant stupid attitude is taken that they are "suggestions coming from unauthorized persons who do not understand anything of design and would be better employed in taking care of their proper work than in interfering with problems which should be kept reserved to the Design Department according to instructions." Or again, if the designer's or the draughtsman's attention is drawn to the difficulty or the impossibility of the production of a proposed design the answer may be: "It is regrettable if production cannot make that." This is a completely wrong outlook. Production can make nearly everything; but there is the question of what it will cost.

The author must say that in his experience of these matters, it is nearly always the production engineer who is most reasonable and who rarely claims the certainty of judgment in problems of design which the designer claims in problems of production. Therefore it can only be recommended—as a logical conclusion from these considerations—that a procedure such as the following should be established. The drawing should be finished in the Drawing Office as far as the knowledge and experience there available permits. It should not then be issued immediately to the workshops, but to an office or department which is nearer to production and more familiar with the arrangements in the shops than the Drawing Office can be. There it should be checked, not only from the point of view of the design, but also—where necessary in consultation with the production engineer proper—to find out whether the design is best adapted to the available production arrangements and can therefore be made in the most economical way. Anything which does not conform to this demand should be ruthlessly rejected; the designer or draughtsman who protests at such a proceeding, if it is done objectively, does not properly understand his job and can only be considered as a danger to the undertaking. Sometimes this arrangement is regarded as a degradation of the position of the designer or draughtsman, so important in itself, but this opinion is one which can only be considered as a misinterpretation of the idea of co-operation.

After the drawing has gone through this procedure and has been returned to the Drawing Office to be finished in the usual way, it is issued to the Production Department and the workshops, and forms an irrevocable and unalterable command which nobody can disregard; any, even the smallest, deviation is inadmissible, unless the permission of the Drawing Office has been previously obtained and the modification authorized by a corresponding alteration of the drawing. There should be a recognized procedure for authorizing modifications after the issue of drawings.

Thus the Design Department or the Drawing Office becomes the spirit which governs the factory, which compels production to transfer ideas, laid down on paper, into the durable material of machines, goods or implements, and shows how far the creative mind has succeeded in translating its plans into stern reality. That is the origin of the spell connected with the activity of the designer, which makes us in our youth consider him as the only really creative engineer. Under the influence of this misconception the young technician is only too easily led to regard the production engineer as a mere executive tool and the administrator as a necessary evil. The author would like to use this opportunity of warning against such a conceit, which may well be the reason why the designer and draughtsman are so often contemptuous of the simplest organizational demands. Just because his position is of such surpassing importance in most industrial works, the designer should be most scrupulous and considerate in all his expressions of opinion and in his behaviour, in order to facilitate the work of those who have to execute his commands.

What, however, are these commands? The designer has only one medium by which he is able to impress the stamp of his intellect, and that is his drawings.

The Drawings[1]

This is not the place to deal with how to make and how to judge drawings. This book is not intended to give a "theory of construction or design," even if any general theory of this kind is possible which does not take into account the purpose of the objects to be designed. Here it is only necessary to deal with what has to be expressed by a drawing in order to make possible its complete and frictionless absorption into the organization of the whole works. Only if the drawings obtain the place in the life of the undertaking which is their due, both by their general appearance as well as by their contents, can the designer properly make his contribution to that economy which is after all the final aim of all industrial work.

The beginner coming from a technical school, of no matter what kind, and starting, as is usual, in the Drawing Office, will rarely be conscious of how much work can be saved and how much ill-feeling and friction, and what mistakes and consequently costs can be avoided if uniform principles are observed in the making of drawings as well as in the choice of the means of expression for conveying the required information. Perhaps the future generation of technicians now growing up will never quite understand this, for if hopes are not disappointed, they will be able to learn at school, and find accepted in practice, the principles laid down by the British Standards Institution, as it is possible that deviations from these principles will tend to disappear in the near future.

To-day we are not so far advanced and the different stages of the development of these processes can be observed in industrial works. Such times of transition are of special difficulty for anyone who has to work in them, and therefore it may be useful if the whole question is not simply dismissed with a reference to the British Standards Institution's publication; some important details should be mentioned, even though not exhaustively discussed, in connexion with the whole organization of the undertaking.

The importance of choosing certain fixed sizes for the drawings must be emphasized and what has been said on the same subject when discussing the size of the stationery applies even more strongly. To have drawings of the same size makes them easier to store and to find again and, whilst it would be uneconomical, even impossible, to make all drawings the same size, standardization of a range of sizes within the limits set by the British Standards Institution is essential. Each undertaking should choose the range of sizes most suited to its purposes.

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[1] *Engineering Drawing Office Practice*, B.S. 308—1943; *Drawing Office Organization*, B.S. 1100, Part 9—1944 (British Standards Institution, 28 Victoria Street, London, S.W.1).

In order that the drawings may be quickly and simply identified a number is given to each drawing, but the system of numbering the drawings consecutively as they leave the Drawing Office is not to be recommended. Usually the drawings are divided into groups, according to the products with which they deal or to some other logical system devised to suit the peculiarities of the undertaking. Each group is given a letter or number, which is used either as a suffix to the drawing number or as the first figures of that number. The main groups may again be subdivided and the second figure used to designate the sub-group, and so on, until each figure of the number has some reference attached to it. Many ingenious systems have been developed in this way. They all have the great advantage that they aid the memory very considerably, since such systems which contain a meaning in themselves are kept in mind more easily than a quite arbitrarily chosen combination of figures. This is obviously not the right place to make definite recommendations. Each case must be taken on its merits, as a detailed knowledge of the works in question and the working conditions is necessary if all the advantages which can be obtained by such systems are to be realized. As an example, however, a system may be mentioned which makes the first figure indicate the size of the drawing in order to show immediately the size of the drawer in which it is kept; secondly a letter indicates the type of product, since all drawings of the same products are kept in the same cabinet; and thirdly there is a number of three digits, of which the first digit indicates the size of the product in question. This example illustrates why such an intimate knowledge of all conditions in the firm is necessary before a useful number system for the drawings can be devised.

A large amount of time-wasting work can be saved if the idea of symbols is logically developed. Parts of machines or plants repeated again and again on drawings need not be completely drawn, but indicated merely by symbols, as is done, for instance, for screws, springs, nuts, etc., or in the circuit diagrams used in all classes of electrical engineering. It is certainly possible for an exaggerated use to be made of symbols, so that drawings begin to look like some form of "secret writing," the understanding of which requires a special and painstaking study, but in many cases there is still a long way to go before this limit is reached.

A question which in the past gave rise to many heated disputes, but which can now be considered as decided in the affirmative, was whether for the purposes of the workshops the *system of one drawing for each separate part* should be applied. The answer to this question is intimately connected with the internal works organization. There may be cases where a negative answer is correct, but these will be rare exceptions. As will be shown, the organization of production will nearly always make it necessary for each individual part to be drawn separately on a single sheet of drawing paper if this part has to be produced separately in the workshops. Only if this method of one part, one drawing, is used, can modern production methods be applied economically (i.e. the planned preparation of work, the logical division of work, and the systematic checking of work), because it provides clear and definite guidance for buying, for the stores, and for economic control. Finally, when considered in detail, it does not prove more difficult or costly than the old method, where a number of related parts were shown on each drawing, leaving the workshops to pick out the single parts.

In general it can be said that all firms engaged in mass production and an overwhelming majority of those engaged in batch production use the single-drawing system. Even firms engaged in single production have to-day recognized the advantages of this system to such an extent that they apply it, although the benefit is undoubtedly smaller than in the first two kinds of production. Only by a system of single drawings is it possible to obtain that careful consideration of the total procedures in the workshops down to the smallest details by which mistakes can be avoided with certainty. The saving in mistakes itself largely counterbalances the undeniably higher costs in the Drawing Office, without taking into account any other advantages connected with the method.

In addition to these drawings of single parts, sub-assembly drawings are required for the combination of the single parts into an assembly which, although it is complete in itself and may be dispatched to a customer, is still only a part of a machine or plant. Finally, a complete assembly drawing or representation of the machine or plant is made by a combination of these sub-assembly drawings. If further subdivisions are necessary, the following different classes of assembly may be distinguished: main assembly, assembly, sub-assembly and part-assembly. How far this subdivision should go depends entirely on the nature of the product; in any case it should make it easier to follow the total course of the work. While the single-part drawings must contain all the information and dimensions necessary for the production of the part, the sub-assembly and the main assembly drawings should show only those dimensions necessary to enable the finished product to be assembled. This is an important rule, because it makes the assembly drawings easier to draw and to read.

If all the advantages of this system are to be completely gained, care has to be taken that the number of the drawing not only is characteristic of the drawing but develops into a description of what is represented by the drawing, whether this is a single part, an assembly, or a finished product. This is done by using the drawing number or symbol in all lists, price-leaflets, wage-tickets, requisition slips, etc., so that in time it becomes familiar to everybody in the works. The advantage of having such a uniform and clear description for all the products and the parts of products of a firm is greater than a superficial consideration will reveal, and in this way the source of many misunderstandings which may cause increased costs is removed.

This type of organization can easily be combined with the work of the British Standards Institution. All the advantages of industrial standardization can be utilized immediately a standard has been adopted for any particular object. The part formerly used and its number are replaced by the standardized part and its standardized number, which naturally will differ widely from the number system of the works. The attention of all concerned will therefore immediately be called to the use of a standardized part. The old part-drawing disappears, and the only alterations necessary are to the assembly drawings, which are easily made since these drawings are generally very clear and easy to alter.

This last remark touches on a universal and very important problem which should be discussed in more detail: How should alterations to finished drawings be made? It is surprising what incredible conditions prevail in some firms in this respect and how often the losses resulting therefrom are regarded as unavoidable. It is only necessary to realize that a drawing is simply and solely a document that gives information about certain events in the past, or that, after being given a limited publicity, is the cause of a number of events which can be justified only because the drawing and the command implicit in it are issued; the drawing, as a rule, remaining the only accurate record of what has happened. And now somebody, with the best intentions, in order to use the same drawing for a second similar case, sets to work and erases important parts so that the original state of the drawing disappears completely. By so doing he lays the blame for any mistakes or inaccuracies on all those who worked according to the original drawing, and destroys the possibility, in the event of a repeat order, of finding in the records of the works themselves a complete and accurate statement of what has previously been sold to the customer. Faulty deliveries, ill-feeling on the part of the customer, and unnecessary costs are the unavoidable consequences. It should not require much consideration to see that it is essential that alterations on drawings already issued to the Production Department should be made only after careful observation of all precautionary measures. The original state of the drawing must under all circumstances remain evident, and the date of the alteration and the name of the person who has made the alteration should be clearly stated in a note which should always be in the same place on the drawing.

Much argument has centred around the question of how the drawings shall actually be made, and whether the designer, when he has sketched out his ideas, should himself go into all details, and even complete the drawings in Indian ink. Again no general answer can be given to this question; the size of the works and the value of the work of the designer are the most important considerations. It is the author's experience that, as soon as the work has attained a certain size and his designs can really be considered as valuable, the designer should devote himself solely to sketching out his ideas, one or several younger technicians having to elaborate all the details under his guidance, with a tracer to do the tracing work and complete the drawings in Indian ink. This method of dividing the labour has stood the test from an economic point of view, but it would of course be economic only in a works of a reasonable size.

As it is nearly impossible for the manager of a large drawing office himself to check in detail each drawing which leaves the office, attempts have been made to relieve him of this job in some way or other; for it must be agreed that such a manager, supervising perhaps twenty real designers, cannot go into the detail work of checking drawings, even if he wishes to. He has enough to do distributing the work to his subordinates, discussing the most important ideas of the designers, fixing delivery dates for each single drawing, and concerning himself with the administrative activity connected with the management of a large department. It is certainly impossible to make him responsible for the correctness of each dimension in a finished drawing, and yet the checking of the dimensions is very important; it is very desirable that, before the drawing leaves the office, someone who has not seen it before and is therefore more impartial than the person who has made the drawing, has the opportunity of checking it very carefully. The appointment of one person to check all the drawings has been tried and good results have been obtained in some cases. The person who has to fill such a place does not need to be a creative designer, but he must have a quick perceptive faculty when reading drawings, great experience in workshop practice and great conscientiousness in his work. If it is possible with his help to find and correct on the drawings deplorable mistakes in dimensions before they have been converted into useless pieces of steel or wood, etc., his salary will by no means have been paid in vain. The drawing should, however, also be subjected to another checking, which is unfortunately only too often forgotten but which becomes more and more important as the influence of modern ideas of production increases in a workshop; that is the examination of the drawing to see if existing standards have been used and standardization carried out wherever it seems possible or desirable.

The influence of the idea of *standardization* should really start not at the finished drawing but at the first moment of its formation in the mind of its designer, and should be included in the first rough sketch. There will be a later opportunity to come back to the question of how this can best be done within the organization of the whole works. It is necessary to mention here only what has to be done to check drawings for standardization. The extent of this checking is at present still relatively large and will remain so until industry has fully adopted the idea of standardization. It will become less and less in the course of future developments; but it will probably never completely disappear. For standardization itself will be influenced by the passage of time, as is everything else connected with economic life, and must change accordingly, otherwise it will become a brake on development and an obstacle to new ideas, instead of an improvement in economics. To observe this change and to follow it continually and quickly in the working of the whole undertaking should be the task of a specialist. In large works, however, where the job would obviously be beyond the capacity of a single person, it is carried out by the Standardization Department which will be discussed in more detail later on; here it is mentioned only because the checking of drawings to see that standardization is followed forms the connexion, which should be a co-operation, between the Drawing Office and the Standardization Department.

Without going into further details of the internal organization of the Drawing Office, one point should be mentioned, of equal importance to the economic control of the whole works and to the forming of a judgment of the ability of each employee. An exact record must be kept of the time, and consequently the cost, each drawing and each complete job has involved in the Drawing Office.[1] Special attention is called to this point because sometimes difficulties are made by the inexperienced, who think it beneath their dignity to let themselves be controlled in this way. This is quite a wrong point of view, for the employee who does his duty honestly has no need to be afraid of such a control, and providing it is not made in such a way that unauthorized people can gain information about the salaries of the individuals, there is no reasonable objection to such an arrangement. It is perhaps worth drawing special attention to this aversion to economic control, which unfortunately is to be found so frequently under industrial conditions, e.g. a refusal to give an account of the time a job takes or whether punctuality is observed in starting and stopping work, or an objection to the ensuring that the petty cash is properly checked and proper records of it are kept, etc. This aversion to reasonable controls is a sign of weak character uncertain of itself and is unworthy of an upright man who has no need to fear publicity. It should not be forgotten that those who act in this way make themselves liable to be suspected of those very infringements that might be found out by the controls.

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[1] This opportunity may be used to draw the attention of the reader to the fact that in some periodicals articles are published, even if not so often as one would like, in which such details are given more space than can be allowed in a textbook such as this. As an example of these articles, a series published in *Practical Engineering* may be mentioned, as they give a somewhat different point of view on these problems than those expressed in this book—

"Functions and Management of the Drawing Office," by C. Langford:
  I. The Designer's Office: Evolution of the Design—Manufacture of the Sample (25th Oct., 1946).
  II. The Production Drawing Office: Production Tracings—Test Room and Production Drawing (8th Nov., 1946).
  III. The Tool Drawing Office: Tooling-up the Design—Designing the Tools —Personnel (15th Nov., 1946).
"Drawing Office Organization," by C. Langford:
  I. The Designs Office (24th Oct., 1947).
  II. The Production Drawing Office (7th Nov., 1947).
  III. The Tool Drawing Office (14th Nov., 1947).

CHAPTER VIII

THE COLLECTION OF DRAWINGS AND BLUE-PRINTS

THE result of the designer's work, and where he first puts down his ideas, is the drawing.

Putting the Drawings in Order

In view of the similarity of the tasks set to the designer again and again, with the probable repetition of orders for exactly identical plants, it is necessary to keep these designs, which in the course of years become accumulations of very considerable value, in such a way that they are always available without loss of time. This is the work of the department for the collection of drawings. Only in this way is it possible to avoid a repetition of work which would soon give rise to economically unsound conditions. This department collects, however, not only the original drawings but also the blue-prints taken from them, and not only drawings made in their own works but also those sent from outside, in so far as they remain in the possession of their works.

In order to preserve the original drawings as far as possible, they are generally not issued to other offices or workshops. They are used only for the manufacture of negatives and from these are taken the necessary blue-prints. Original drawings and negatives are kept separately from each other, so that complete destruction by fire or other accidents is rendered relatively unlikely. The drawings are best stored in cabinets with shallow drawers so that not too many drawings can be put into one drawer, as this makes taking them out more difficult. As searching through these cabinets is troublesome and time-wasting, and the drawings can be filed in them in only one way, usually in order of number, one or more card indexes are necessary so that drawings may be found under various headings, when they are wanted for new orders or as a basis for new designs. In these card indexes each drawing is represented by one card, and as it is frequently very difficult to illustrate the total content of a drawing by its title it has been suggested, and in a few instances put into practice, that all drawings should be photographed and the photographs used as the cards, the necessary references being made on their backs; this is certainly a good practice, but a costly one.

In order to explain the purpose of these card indexes an example may be useful. A factory making steam engines has the system of numbering its drawings so that all drawings for a certain model *A* show first this letter and then successive numbers, similarly for a second model *B*, and so on. A new model *X* is to be designed and the requisite piston made. In order not to have to get out all the drawings of all the models, there is in addition to the main card index—where the drawings are in number order with a description of the contents of the drawing on the card and possibly even with a photograph of the drawing attached—a second or auxiliary card index, in which the cards are grouped together under headings referring to the individual parts of the various models. In this case the required drawing is sought under the heading "Pistons."

The Issue of Drawings and Copies of Drawings

The card indexes are also used to record how many blue-prints of the drawings have been made and who has received them. This is very important, as otherwise it may happen that not all the blue-prints which have been made are withdrawn from the departments and workshops when an alteration to the drawing becomes necessary. If this is not done some shops will be found working to the blue-print of the altered drawing, and others to the original drawing; it is evident what damage could arise.

For the rest it may be sufficient to remind the reader of the description which has been given of the working of the Filing Department, for the task of keeping and issuing drawings in the department which collects drawings and their copies is very similar. It should be mentioned as especially important, however, that drawings should be issued and blue-prints made only against a written requisition. These requisitions are surrendered when the drawing is returned as evidence that the return has been made. Requisitions for new blue-prints are valid only if signed by certain leading and specially authorized employees.

The Blue-prints

Drawings are usually copied by making blue-prints from them. This work is generally closely connected with the department which collects the drawings. There are, of course, businesses which specialize in this kind of work and which exist to-day probably in every large town; but as soon as the demand for blue-prints grows to, say, about 200 square yards per week the question of the installation of some apparatus for making them should be investigated, in order to become more independent, to obtain the prints quicker, and to avoid having to deliver the drawings into the keeping of strangers. The production of the blue-print paper itself can, however, be recommended only where it is used in considerable quantities, as it is generally to be obtained in good quality and at a reasonable price. As already mentioned, the department for the production of blue-prints should be considered in the same way as any other production department; therefore the costs of the products have to be calculated and they should be bought from outside as long as this is cheaper than the production of blue-prints in the works.

It may be recalled that, although blue-prints can be made by natural light, arc-light is usually used to-day. Instead of intermittently working appliances, in which the printing paper and drawings are put into frames and the light moved across them, continuously working machines are available and the most perfected in this branch are those in which the sensitive paper together with the original copy slowly passes through the machine under the source of light, the paper then being automatically developed and dried. In this case the work is almost independent of the operator's skill.

Often, especially in large firms, the Blue-print Department is enlarged to a photographic studio, where all kinds of photographic work can be done, whether making photographs for advertising, for investigation of working processes, of materials, etc., or taking a photographic record of some arrangements for facilitating the work in some office or workshop. The reader will remember that this subject has been dealt with earlier on in connexion with the Correspondence Department, when it was pointed out how the production of many duplicate copies may finally develop into a real printing office. All the considerations which applied to this development apply also to the expansion of the Blue-print Department, and therefore need not be repeated. It is desirable, however, to repeat the warning to beware of frittering away money, resources, or time on too many activities. It must be certain beyond doubt that the new appliances and equipment will make money and not waste it.

CHAPTER IX

THE PATENT DEPARTMENT

THE ideas of the designer as laid down in the drawings can, if they are new and valuable enough, be protected by patents or copyright in designs. It is the work of the Patent Department of the works to provide for this protection, to observe what is considered necessary in this respect by competitors, to keep watch lest one or other of the competitors infringes the patent rights of the firm, to take care that the protection obtained remains intact by paying the fees in time, to obtain licences from and to sign contracts with inventors and other owners of patents and to see that they are properly observed, to examine inventions together with the specialists of their own works, etc. The Patent Department must have the closest connexion with the Drawing Office, for only then can both departments really serve their purpose. What is done in one department must be known to the other. The best arrangement, therefore, is for both departments to have the same manager, or, if that is not possible because a suitable personality is not available, for one of the two managers to be the superior of the other.

The Patent Agent

There has been much discussion on whether it is correct to have a special Patent Department in the firm, or whether it would not be better to work directly with a patent agent. The answer can only be that it depends on the amount of patent work done. It is an economic proposition only when there is enough work to keep a patent specialist occupied all his time. The Patent Department of a works, of course, soon builds up a body of special knowledge on those patents which are of particular interest to the firm. An independent patent agent, however, who is nearly always active in all possible branches of the business, is unlikely to have this special knowledge and may take considerable time to collect it, thereby increasing the costs. In addition, the fees of an able patent agent are in themselves usually very considerable. On the other hand, for difficult legal work such a profound knowledge of the patent law is necessary and the drafting of the documents requires such understanding and power of expression and needs such an experience of the patent laws, that in all cases of importance involving decisions of consequence it is beyond all question better to consult an experienced patent lawyer. This is especially important in the case of smaller firms. Even for larger works, however, where specialists in patent law who can be considered as equal to independent and distinguished patent agents are employed in the Patent Department, it is a commendable practice to consult an independent expert in especially important cases. For these are often decisions where one wrong step can bring about considerable losses to the firm.

The Cost of the Patent Department

This is one reason why the Patent Department in some large firms has assumed an extraordinary degree of importance. The management are aware of the fact that their patents are very valuable assets which must have expert care and attention, but in addition a well-managed Patent Department, always on top of its task, can supply to all interested departments of the firm that knowledge and experience which can prevent mistakes and misjudgments in design and production and in the conclusion of contracts involving patents, as well as being able to guide research into useful channels. These and similar services may far outweigh the not inconsiderable costs of the Patent Department. It is obvious that these costs should be decreased as much as possible, especially by a suitable division of labour, i.e. by leaving to the patent engineer the really professional tasks and relieving him of all routine jobs, such as drawing and tracing, as well as by giving him good secretarial assistance.

One way of decreasing the costs of patents in suitable cases is for a number of connected firms with common interests to agree to share the costs of buying important patents, which would be too expensive for any one of them alone, e.g. the Owen bottle machine. Another way is to bring together the separate patent departments of each firm into one joint office, the costs of which are then allocated on some previously agreed scale. It is almost unnecessary to point out that this last method may have many disadvantages, and can be recommended only in special cases where a very close connexion already exists between the interested parties.

CHAPTER X

THE LIBRARY

CLOSELY related to the work of the Patent Department is the examination of all patents as they are published, and it is natural that together with this job goes the reading and abstraction of professional literature, books, periodicals, etc. It depends on the circumstances of the firm, and especially on the available staff, whether this work is done by the Patent Department or whether a separate department is established which is then linked up with a library, containing as far as possible all significant publications of professional and general interest.

Arrangements For Borrowing

It seems superfluous to describe the arrangement of such a library, the manner of its administration, the method of issuing books and periodicals, etc., for the principles which have to be adhered to are generally known. As a result of practical experience, however, it can be pointed out that full advantage of the library will only be obtained if the borrowing of books is made as easy as possible and all bureaucratic difficulties are removed; above all, the time of day when the library is open should be carefully chosen so that it is most convenient to the employees of the firm.

Periodicals

Periodicals should be circulated through all departments in a fixed sequence. They should be put into folders showing on the inside of the front page the exact contents of the folder and order in which the departments are to receive it, as well as the dates for entering and leaving each department. The managers of departments must confirm the passage of the folder through each department by initialing the folder. Nothing is allowed to be taken out of the folder, nor is the folder allowed to be locked in a cupboard or a drawer. It must be passed on without fail as soon as the reading time of the department in question is over. These rules may appear unnecessarily strict, but if they are not made and kept it will be nearly impossible for the library to function properly. For example, a library must produce without delay any article asked for, otherwise it might just as well not exist; therefore the librarian must know exactly where all the journals in his charge are at any given time, so that they can be produced at once if needed. Again, if the reading time for the individual offices is not determined from the first, attempts may be made to extend the time immoderately, and subsequent departments will receive the journals so late that the contents are obsolete or of less importance.

It may be regrettable that the right to study these journals at any time during business hours cannot be extended to all employees, but this is almost impracticable. In a well-managed competitive firm the working time of each employee is already fully occupied, and if usually happens that when he has reached a status where he is more or less independent he is far too busy to read in working hours. Besides, in a large department it may not be possible for reasons to discipline, for there is unfortunately nearly always someone who would abuse a permission to read journals. An attempt should be made, however, to inform all those who may be interested, for whatever reasons, professional or commercial, of the appearance of important publications and to encourage the reading of any book or article in spare time. This can best be done by arranging for a reading room to be open after business hours, where all new books and journals are displayed for a few days before circulation.

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PART III

PRODUCTION PLANNING AND CONTROL

CHAPTER XI

PRODUCTION PLANNING

It has been mentioned that it is expedient to have between design—the place where things are first thought of and put on paper—and production—the place where things are made—a middle section which has to form a bridge between them and to endeavour to reconcile those conflicts in which they are unfortunately so often engaged. This section should, however, take over also a lot of other tasks, which may be identified by the fact that they comprehend nearly all preparatory work which has not been done in the design section, so that production receives an order ready in every respect for execution. Production need then only concern itself with the work proper to production, that is in the execution of the design promptly and accurately and in the quantities required.

Resentment Against the Innovation

This idea has been bitterly attacked. "It may be all right in the U.S.A., but it is against the tradition and mentality of this country," is the complaint. The new section is considered as an interloper in the organization; design and production believe that their importance in the undertaking has been reduced, and join hands for once against this new section. As a matter of fact, it is only a logical extension of a principle long recognized as being generally correct for production itself, namely the division of labour. As competition grows, the more important it becomes to use any means to increase production and economy of working. In consequence this section between design and production must be made more efficient and more must be done for its development in order to obtain throughout the whole of the organization that clarity of direction and promptness of execution which alone guarantees the proper distribution of responsibility and the profitable operation of the firm. It is of course obvious that any exaggeration of the principal idea has to be avoided when developing this linking section, but it can be stated that its establishment in some form has been definitely proved to be an absolute necessity. Further explanation is superfluous, since the following description of the tasks and duties usually allotted to this section will indicate all that is required.

For some time there were doubts about the name to be given to the new section, and some confusion was the consequence, but to-day the expression "Production Planning" is used so commonly that there is almost no doubt that it will become generally known by this name.

It is usual to speak about the control of any work only after the manner of execution of the work has been explained; but in the present case it is considered advisable to depart from this rule and to deal with the "control" of "Production Planning" at the same time as its operation is explained. The reason is obvious; this control will be more easily understood if the operations involved in planning are still fresh in the memory of the reader. Thus the heading "Production Planning and Control" has been given to this third Part of the present book.

Fundamental Principles

In order to be clear about the tasks to be settled by the various departments of production planning it is best to return to the question which has been asked before, the answer to which has been deferred until now: How, on receipt of a customer's order, are all departments of a firm to be told what they have to do in order to fulfil the order as expeditiously and as economically as possible?

No method will be described in detail, since the development of such an organization depends much too much on the peculiarities of the products and the circumstances under which the undertaking has grown up. Here only the explanation of the fundamental principles is in question and it must be said that even these are not completely undisputed. What is to follow is to a large extent the result of a co-operative research in which the author participated and which he later proved, by putting the results of the research into practice, to be a satisfactory basis on which to build an organization.

CHAPTER XII

THE ORDER DEPARTMENT

ALL work to be done in the works, and consequently all the orders giving instructions for this work to be done, can be divided into two groups; those for producing saleable goods on the one hand, and those for internal service on the other hand. The first group may be subdivided again into customers' orders, warehouse orders, and stock orders, the second into orders to obtain new plant, orders to maintain plant, and orders to keep production going. It will be necessary first to make clear what is actually meant by these expressions.

Customers', Warehouse, and Stock Orders

It is to be regretted that in practice clear definitions of what these orders are and what purposes they fulfil are often wanting, and many misunderstandings are the result; but as clear definitions are fundamental to the complicated and important work which has to be discussed, an attempt must be made to explain and define each of these expressions as strictly as possible.

The Customer's Order is the original instruction from a customer, which is the only sort of order so far discussed in this book. For our present purpose it is all the same whether this instruction reaches the firm directly from the customer or through a representative, traveller, or branch office.

The Warehouse Order results from a forecast made independently in the works, on the assumption, based on past experience, that one or several customers' orders exactly identical with the warehouse order are to be expected.

The Stock Order is based on the following consideration. It is very rare that an order has to be fulfilled where each single part has to be made individually; there are always parts which are common to many different orders and which are therefore produced in as large quantities as possible in order to obtain the greatest economy in production. They are kept in stock in the stores ready to be used as occasion arises. The attempt to secure the utmost economy, which is becoming more and more necessary as competition increases, makes the more frequent application of this expedient essential and it should be taken care of as far as possible during the development of the drawing. And so from this consideration there arises quite spontaneously the standardization of individual parts, such as screws, nuts, bolts, spindles, etc. Mass production, or at least batch production, can be introduced even where, on account of the choice or the different needs of the firm's customers, it is not possible to make a uniform finished product which in itself would provide a basis for mass production. Thus a new kind of order is introduced—the stock order—which is of greater or less importance to the works according to the type and quantity of the production.

Going a step further and assuming that not only are a large quantity of these standardized parts used in the factory in question but that similar parts, differing perhaps only in unessential details, are also used in quite a lot of other works, the idea grows of standardizing these parts not only for one works, but for all, and the idea may even extend to a whole industry. In this way the foundation is laid for creating separate factories in which the standardized product is made. These factories, by virtue of the much larger quantities they produce, are able to manufacture much more economically than the first firm, with which this consideration began. If the development proceeds as far as this, the carrying out of stock orders will be no longer, or will be only in exceptional cases, the concern of the works which started standardizing, as to a large extent these parts will be purchased finished as if from an outside firm. The result will not only be a saving for the single undertaking, but, what is still more important in present circumstances, it will benefit the national economy in various ways, quite apart from other advantages such as easy and rapid replacement of broken parts, etc. This is one of the reasons for the exceptional importance of the work of the *British Standards Institution*, which has been mentioned already and of which more details will be given later on.

The Issuing of Stock Orders

It should be obvious that stock orders should be neither executed nor issued unless instructions are given by a senior executive, and this is usually the case. This senior executive must have some way of being informed simply and quickly about the stock position, so that he can issue the stock order. The usual method is that the stock, which may be parts or materials, is kept in a store; as soon as the stock in store is decreased below a certain minimum quantity by requisitions from the workshops or by supplying certain customers, or for any other reason whatsoever, a new stock order for this part or material has to be calculated, the requirements being based on past consumption, and this new stock order has to be given to the workshop or the Purchasing Department. This method, however, expedient and useful though it is, must be employed very cautiously. To calculate future requirements from past records may be correct in nine cases, but in the tenth it may be completely wrong. The taste of the customers may have changed; technical progress or change of design may have altered the construction of the finished product; and a part used by the workshops up to the present in perhaps many hundreds may be reduced to the number of parts necessary for fulfilling customers' or warehouse orders for spares and for existing machines, the part thus becoming a drug on the market if the stock is not cleared in time. Statistics of customers' orders made immediately these orders are received can be a help in enabling the interval between the reception of sufficient customers' orders to reduce the stock to its minimum level and the execution of the next stock order to be used to correct the stock orders quantities. These statistics may come too late, however, and it is more important to keep in intimate and constant touch with the departments of Advertising, Sales, and Design on the one hand, and with the Production Planning Department and even the general management itself on the other hand.

This question is extraordinarily important; the decisions taken can have an enormous influence on the prosperity of the whole concern and they should in no circumstances be left to subordinate members of the administration. As usually the managing director or the general manager is not able to go thoroughly into all the details which such decisions require, the question arises as to who should be the specialist to be entrusted with this task. Again this is a problem which can be solved only by an intimate knowledge of the personalities available. Here it is assumed that it would be the manager of the Production Planning Section, but it is possible that the sales manager might be a more suitable person, and hence it is often the case that the part of production planning dealt with here under the heading "the Order Department" is considered the work of the Sales Department. As will be clear from the following explanation, the work of the Production Planning Section would provide the right background to gain the knowledge and qualities needed for handling the problems which have to be dealt with when the structure of the orders within the works is built up. Of course in principle the last word should be with the general management, to whom the most important decisions should be submitted for approval, preferably by oral report. How far it is possible to disregard this measure of caution and to leave the decision to a sectional or even departmental manager depends upon his personality. It would be possible to set a limit on the value of the stock order which could be issued on the authority of the departmental manager alone, stock orders of greater value requiring the authorization of the general manager; but all these mere mechanical regulations are of doubtful value as they can always be evaded in some way or other. A better way is to give the manager of production planning a general authority to issue all stock orders and leave the general manager to check by occasional samples taken at random that this authority is used only in a reasonable way and to the best economic advantage.

Orders For Internal Use

Although the orders for internal use are considered a nuisance in nearly every firm it is not possible to do away with them. As already mentioned they are divided into—

(*a*) *Orders for Investment in New Plant.* These are the orders which result in an increase in the value of buildings, plants, machinery, etc.

(*b*) *Orders for the Maintenance of the Items Mentioned under* (*a*). These are all those orders by which damage caused by use, age, or accident are repaired in such a way that the original state is as nearly as possible restored. These are all the jobs which are known in the works as maintenance and repairs.

(*c*) *Orders to Keep the Production Going.* Under this heading are included all those things which have to be done to enable production to be carried out in an orderly way on serviceable plant, and which do not directly concern the manufacture of the saleable goods, e.g. all tidying-up and cleaning of workshops, machines, tools, etc., supplying light and power to the shops, the lubrication of power transmission equipment, etc.

Special consideration is necessary for orders concerning the maintenance and replacement of the stock of tools which must be kept in the tool stores. There are three classes of tools: (1) special tools, which are of unusual form and have to be produced in each works to suit the special purposes for which they were made; (2) tools which can be bought from outside but which, for reasons of an economic or technical nature, can also be produced in the works. This frequently happens with such tools as milling cutters and cutter heads and also with some taps and reamers; (3) finally, there are also the usual trade tools, such as tongs, pliers, hammers, files and drills, which are hardly ever produced in the works but are bought from outside.

It is difficult to classify these orders for tools into one or other of the above main kinds of orders, and yet this is necessary if an orderly and accurate calculation of costs and a reliable survey of the consumption of tools is to be made. This information must be available before any opinion on the management of production can be formed. Each of these three kinds of tool orders requires a different treatment according to its nature; it may even be possible that two different orders of the same kind cannot be dealt with in the same manner without causing confusion and loss; it is for instance possible that one of two different orders for special tools is considered and dealt with as an order for investment in new plant, and the other, although it is also a new item, nevertheless has to be treated not as an order for tools but as a maintenance order. The tool orders of the two last kinds, however, have so much similarity of character with stock orders that it is usual to settle them in exactly the same way and therefore to include them with the stock orders. The whole problem of ordering tools is not simple and will be mentioned again later.

The Order Number

Quite apart from the problem of how to organize the Production Planning Section in order to keep control of the immense number of orders and to be able to carry them out and deal separately with them in the workshops, in dispatch, in bookkeeping, etc., some clear method of identification must be introduced so that each individual occurrence during the work can be readily recognized and classified with the order to which it belongs. The order number is universally recognized and used for this classification, and it can therefore be taken as a settled principle in an industrial concern that no work of any kind should ever be started before the order number which belongs to it, and on which it has to be booked, is known.

This is true not only for customer, warehouse, or stock orders, where this principle is accepted to-day almost without exception, but also for all orders for internal use, where, even in otherwise well-organized works, conditions can be found which are much in need of improvement. It must be admitted that the problem of giving numbers to orders for internal use is not so simple as it is for customer, warehouse, or stock orders; but it is not insoluble. It has been proved to be possible in many cases and it is recommended that the strict execution of this principle should be insisted upon.

Separation of the Various Kinds of Orders

An important improvement in control can be brought about by differentiating from the beginning between the various kinds of orders. For this purpose two of the most usual expedients are to use different-coloured order forms or to make the order number itself indicate the classification of the order, either by selecting one series of numbers for each of the different kinds of orders or by using a letter as a prefix to the order number. Thus each of the various kinds of orders may be numbered from 1, but the customer orders may be left without a letter, the warehouse order may be given a prefixed letter *W*, the stock order an *S*, an order for investment in new plant an *N*, a maintenance order an *M*, and an order to keep production going a *K*.

The two last-mentioned kinds of orders may be the cause of many difficulties. They deal very often with urgent work. A toothed wheel in some machine tool gets broken, the winding of an electric motor is burned out, a bearing on a transmission shaft seizes up, etc. The trouble must be remedied as quickly as possible; but the person responsible for seeing that this is done is completely absorbed in his work, and it can therefore be easily understood that because of the urgency of the job he does not carry out the prescribed formalities at once but leaves them to be done later on, and may possibly even forget them. As a consequence the workman who does the job does not know which order he is dealing with, as no order number is given, and either his wages are not booked correctly or a disproportionately large amount of work is necessary to find out subsequently what the order which has been carried out really was.

In this description of working conditions as they can actually be observed in some shops to-day, no account has been taken of the fact that it may even be in the interests of one or other employee to conceal such repair work, which perhaps he himself has rendered necessary by his carelessness. It may be, therefore, a convenient excuse for him to be able to say that he was in such a hurry that he had no time to write out a regular order and have it checked by a competent person. Attempts have been made to stop these evasions by the use of the so-called *fixed order numbers* which in some firms are applied in elaborate detail. Each building, each machine, each stock room, each kind of tool, in some cases even individual parts of important machines, have certain fixed numbers, which must be quoted whenever maintenance work on the parts in question has to be carried out. Similarly, certain series of numbers are provided for the work to keep production going in the various workshops. In this case ingenious systems have been devised by which it is possible to find out from the number not only what work has been done, but also where it has been done. As can be seen, this idea has something to recommend it; and yet it cannot be considered as unconditionally desirable, for it should not be overlooked that it is impossible to make certain that the work done is properly charged by workers or foremen to these fixed order numbers. It may be that work which has nothing to do with them may be charged to them, perhaps to conceal defective production work or to falsify the time spent on piece rates.

It has therefore been proposed that these fixed numbers should be used only when the work does not require the use of any material which could be also used in production. This would reduce the possibility of abuse but would not completely exclude it, for it is almost impossible to keep the workshop completely free of excess materials, which may even have been accumulated by the foreman to provide for a possible emergency. A second suggestion which seems considerably less satisfactory is to present each order form for maintenance work, etc., separately to the production manager for countersigning. This manager is mostly so overloaded with work, however, that he should be spared such detail work, which only too soon becomes a mere formality. Another suggestion is to keep orders on fixed order numbers limited to a certain low amount, and as soon as this sum is spent to ask for a new order under a new number to which the costs are transferred. This gives some guarantee against abuse; but it leads to so much office work and is such a prolific source of mistakes that this suggestion too can be recommended only conditionally. It cannot be denied that the fixed order numbers, though in many cases they are good, perhaps even necessary, means of facilitating the work connected with the supervision of the costs of production, need a strict and continuous observation by the management to make sure that the costs are correctly booked.

The Order Book

That the order sent by the customer and the customer's order, spoken about in this analysis of the kinds of orders, are the same with regard to their material contents, the reader will certainly have understood; the difference between them is only that the second has been translated into the language of the workshop, and is the consequence of two different points of view from which the two parties, the department which accepts the order and the department which fulfils it, consider the same subject. Thus both documents can receive the same order number, and for the sake of greater simplicity this will generally be the case. It is, however, not absolutely necessary, and how this is decided will depend on the "system of order numbers" that has been developed. In order to be able to number each order as it is received and to keep a record of the numbers used, the order book is almost universally employed in industry, and in view of the task it has to fulfil it is usually kept in the form of a bound volume. It should contain only those notes which are absolutely necessary to identify each order. Combining it with other books or lists, from which statements about finishing, dispatch, accounts, etc., are taken, has not proved satisfactory. The keeping of this order book, and through it the fixing of the order numbers, is the first and a very important task of the Order Department. It has already been pointed out that a close connexion with the Sales Department is necessary in this task, and experience has shown that it is desirable, if not absolutely necessary, to deliver to the Order Department an exact and faultless copy of the customer's order, which first enters the Sales Office, and is usually retained there for checking and filing purposes. This may be regarded as "red tape," but must be considered essential as soon as the works have grown to a reasonable size. It will always be the case if the sections Sales Promotion and Production Planning have been as clearly separated as is suggested in this description.

The Order Department has now to investigate which of these customers' orders can be passed on in a materially unchanged form as a customer's order to production and which are to be retained to form a basis for warehouse orders, or, expressed otherwise, which orders require new production in the works and which orders are covered either by finished products in the warehouse or by warehouse orders actually in production and soon ready for delivery to the warehouse. For those customers' orders which are to be fulfilled from the warehouse, of course, no instruction of any kind has to be given to the workshops, for it is sufficient to inform the warehouse. It is a sign of a good organization in the whole undertaking if success is achieved in delivering quickly to the customer such finished products as have been considered in principle as being suitable "subjects for warehouse orders" and as therefore not needing to be manufactured "as ordered." Indeed the person who makes out these warehouse orders must always be conscious of the great responsibility he takes upon himself. It should never be forgotten what enormous damage can be caused by "overstocking" the warehouse. Quite apart from the danger that such warehouse stocks may become obsolete, the loss of interest by investing too much capital in finished goods can alone consume the whole profit resulting from the production; indeed, examples could be given where profitable undertakings have become bankrupt by over-stocking their warehouse. Here, as always, the great art is to discover the mean, an art which cannot be learnt from books.

Only one consideration remains to be dealt with; for the rest, practice is the best teacher. Among the customers' orders which have to be fulfilled as far as possible from warehouse orders, *orders for spare parts* are of special importance for some industries, as they are vitally necessary for some machines in case of breakdown. Here it does not pay to be too cautious in keeping a stock of spare parts. It can be of decisive importance for the reputation and even for the whole success of the firm that the customers receive the spare parts they need. In this case speed is of the greatest importance, and the route which such a customer's order has to follow between its reception and the eventual dispatch of the goods from the warehouse on their way to the consumer should therefore be made as simple as humanly possible. All unnecessary routine between sales and dispatch should be eliminated; e.g. a direct intercourse between these two sections can be allowed in such cases without damage or loss, provided that simultaneously Production Planning and the Stores are kept fully informed and are able to keep their notes, lists, etc., up to date, by receiving, say, a copy of the instruction from Sales to Dispatch.

CHAPTER XIII

THE PART LIST DEPARTMENT

THE second important function of production planning which arises as the orders pass through the works is the preparation of a part list. In the majority of the cases, i.e. in all cases where the finished goods are composed of a number of individual parts assembled into a whole, it must be completed before transferring the order to production. Besides the drawing, the part list is the only way of giving all the other departments of the works information on how to carry out the orders in detail; the part list is, however, also an important instrument in the hands of the person who has to see that the order is finished by a certain date according to a carefully thought-out plan. It is not necessary to say more to point out the extraordinary importance of the part list, and it does not seem necessary to discuss further the formerly much disputed question of whether the part list is really needed or not.

Even to-day there may be people who believe that they could go on working without any part list; but they deceive themselves. For if part lists are really not made in the works in question it is chance or the result of especially favourable working conditions—which can change at any time—if everything works well: or else, as is probably the case, separate part lists are made by each department, probably with a good deal of overlapping, and as no complete part list ever appears it is assumed that one is never made. Sometimes such a list may wander from the place where it belongs into the foreman's office, or even into the hands of the worker on the job. If the folly of relying on the memory of an employee or worker is to be avoided a list should be properly compiled.

Drawing Part List and Order Part List

The question now arises: To whom is the making of the part list best given? And, as so often when discussing such questions, it turns out that it is not precisely clear just what is understood by the term "part list." Of course it is easy to give such a definition as "a part list is a list of all parts, including even the smallest, which are used when carrying out an order." But this explanation defines only one special kind of part list, which may be best called the "order part list." There are also part lists which are closely connected with drawings and can be found on assembly drawings or drawings of groups of parts and to which the name "drawing part list" may be given. Obviously there is little difference between them in a works where the "system of single part drawing" is carried through to the extreme, as on a single part drawing of *one* part alone no real drawing part list is necessary. The order part list can be built up by listing the single part drawings and putting opposite each drawing the number of single parts required to be made to complete the order.

These explanations give the key to the answer of the question asked above. Assuming that the modern system of single part drawings is used in the firm—and this is recommended in all works of a reasonable size producing finished goods composed of a number of separate parts—the drawing part list is generally limited to the sub-assembly and assembly drawings of the finished goods, and they should be made by the drawing office either on the drawings themselves or on special sheets in some way clearly connected with the drawings to which they belong, preferably by identical numbers, the part list being identified by a letter placed before or after the number. The order part lists are the job of the Production Planning Section and they are built up from the sub-assembly and assembly drawings, using the single part drawings and taking into account any special demands contained in the customer's order for which the order part list in question is set up, e.g. number of finished goods ordered, etc.

Contents and Production of the Order Part List

Besides the usual particulars contained in the drawing part list such as: number of pieces, denotation of part, drawing number, store number (if it is not preferred to keep the drawing number and the store number the same as mentioned above), material, weight, etc., it should be evident from the order part list whether the piece in question has to be manufactured in the workshops especially for the order in question, whether it can be taken from stock, or whether it has to be bought from outside.

Here a very important side of the work of the Part List Department becomes evident; it is to keep in continuous touch with Production, the Stores, and the Purchasing Department. For different measures must be taken depending on how it is decided to procure any particular part. Supposing that a piece has to be manufactured specially in the works, a corresponding order has to be issued to Production; if it is supplied from the Stores it has first to be confirmed that there are a sufficient quantity of parts in stock. If this is the case, the Stores have to reserve them for the order in question until they are asked for; if it is not the case, the Stores have to be provided with more parts by the issue of a corresponding stock order, which again can be either a manufacturing order for the works themselves or a purchasing order to an outside firm about which the Purchasing Department has to be informed. Finally, if it is clear from the first that the parts must be bought from outside in the exact amount needed to complete the order, then the Purchasing Department has to be given this information. This whole job of clearing up, making a decision and sending out an order is a matter for the Part List Department. It uses the order part list for fixing all necessary dates; and this list must be built up so that all these notes, figures, and remarks can be kept well ordered, clearly set out, and entered opposite each part.

It has been suggested that all these dates need not be entered into the order part list itself, but that a special form should be used, called the *preparation sheet*, which could be drawn up in such a way that it could be glued to the part list if necessary. The work to be done is, of course, practically the same, but the sheet has the advantage that at places where the order part list is necessary, but the preparation sheet is not, it saves paper, and a more simple form can be used. Therefore the decision on this point depends on whether and in what way the order part list is needed in addition to its use in the Order Department and perhaps in the Costing Department. Again this is connected with many other questions of organization, especially how the issue of work into production and the workshops is arranged. Experience shows that an attempt should be made to give to Production proper as few copies of the part list as possible. Of course it is possible to decrease by some methods of duplication the costs of issuing a large number of copies, and to arrange the list itself so that it is not necessary to send the whole part list to every section of Production but to divide it so that each section receives only that part of the list which is of interest to it. This measure, however, only decreases, it does not eliminate, the cost and the other disadvantages which the handling of a large quantity of paper involves. As a matter of fact it is usually possible to arrange matters so that Production receives only one copy of the order part list and that is arranged to suit and goes to the assembly shop. A part list which is drawn up to suit the assembly shop has a double advantage, for not only does the assembly shop receive a part list which has all the parts as far as possible in the order in which they will be required, but it is also the best way of making sure that the person who makes the list does not forget any parts. For when putting the list together he need only concentrate on the building up of the plant, machine, instrument, or whatever it is, and he has no longer to take into consideration in what workshops those parts are produced or machined. This question of the issuing of part lists will be discussed again later on, when describing the delivery of material from the stores to the workshops, but there also it will be found that the issue of a large number of copies of the part lists can be avoided.

Nevertheless, it will be expedient so to arrange the lists from the first that they can be easily duplicated, even if only to avoid having to make out the list again in the event of a repetition of the same order. Building up a part list to suit assembly leads frequently to parts which fit each other being grouped together, thus forming the basis of stock orders not only for individual parts but for groups of parts and sub-assemblies also. In this case again only sections of the order part list need be used. In many cases it will be possible to keep stocks of complete sub-assemblies ready for use in plants or machines of differing efficiencies and sizes. Sub-assembly part lists will be made for each sub-assembly and by combining all such sub-assembly part lists for a certain machine, plant, apparatus, etc., the comprehensive main part list can be built up. Where production allows this method to be followed to any extent it can be strongly recommended. Besides the advantages already mentioned it has also a good educational effect, emphasizing the importance of the standardization of parts, drawings, and designs.

The above remarks should clearly show the quite extraordinary importance which the part list has in the operation of quite different departments in the firm. Originating from a simple enumeration of the individual parts required to make the object illustrated by a drawing, and forming a comparatively unimportant part of this drawing, it has little by little attained an independent life and has become the basis of production. The part list has other very considerable advantages, provided that the person who is responsible for it produces it carefully and makes use of it intelligently. Nowhere will a bureaucratic treatment do so much harm as in the preparation of the part list. If it is done in a purely mechanical way without care for the *results* the most excellent and ingenious system may develop all kinds of drawbacks.

The part list and preparation sheet can become the connecting link between Design, Stores, Production, and Purchasing Department, and whoever has to prepare them must do his work thoroughly and avoid the patronizing attitude of claiming that because he has written an instruction it is someone else's fault if it is not carried out. He has to convince himself by personal inspection and consultation that correct instructions have been issued and have been carried out punctually, etc. The right "part list man" will be in the office only for a comparatively short period of his working time and, because he is so near to the actual making of the products, his work, which an outsider may easily designate "mechanical" and "stultifying," will be both interesting and absorbing.

CHAPTER XIV

THE ANALYSIS OF WORK

WORK can be analysed in many different ways, which may be all of equal value, but it is obvious that if some kind of standardization is possible it will assist mutual understanding, which is reason enough for making the attempt.

The method proposed here was first suggested and successfully applied in general engineering; it was then transferred to other branches of industry—and with some adaptations it could be applied in nearly all cases. Examples, illustrated by Figs. 1–3, are the production of a pulley by machine moulding, of an electric lighting standard, and of a toilet roll. The definitions of the various technical terms used hardly need any further explanation, but they are given in the hope that this may be considered as a contribution to the standardization of nomenclature.

Definitions of Technical Terms

The Production Order or *Works Order* is the document authorizing the execution of work in the factory and results from the translation of the customer's order into the language of the factory or of the works, as explained in Chapter XII. The term is applied not only to customers' orders but also to warehouse orders and stock orders. The production or works orders are arranged either according to the extent of the order or according to the nature or sequence of the work; in other words they conform either to the *Production Plan,* which is built up from product, production groups or assemblies (main and sub-groups), and jobs, or to the *Working Plans* of the different jobs, built up from processes, operations, motions, and motion elements. A *Process* is a complete series of operations for the purpose of production performed by one worker, or a group of workers co-operating at one work place. An *Operation* is the next smaller unit, or a stage in a process of production, carried out at one working place. A *Motion* is a group of actions of a worker in the course of production, or preparation for production consisting of several motion elements. Sometimes several motions may be treated as one motion for simplification of calculation and this is called a *Motion Group.* A *Motion Element* is the smallest observable

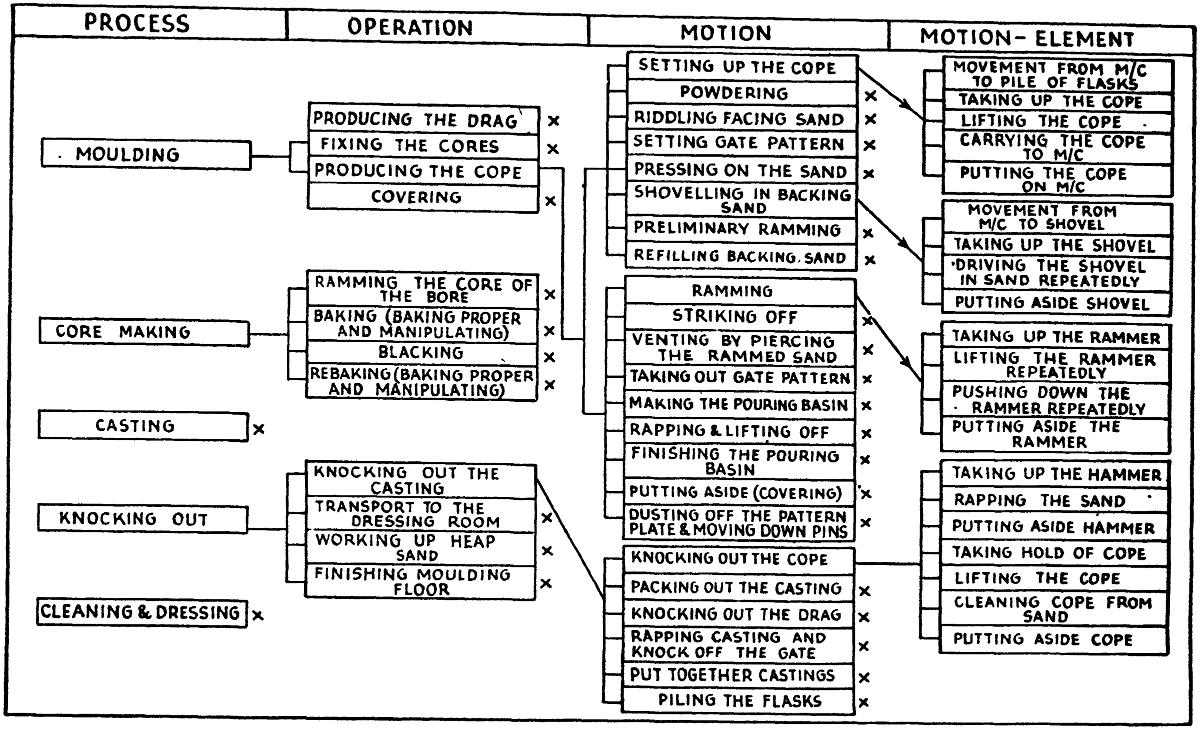


FIG. 1. WORKING PLAN OF THE CASTING OF A PULLEY

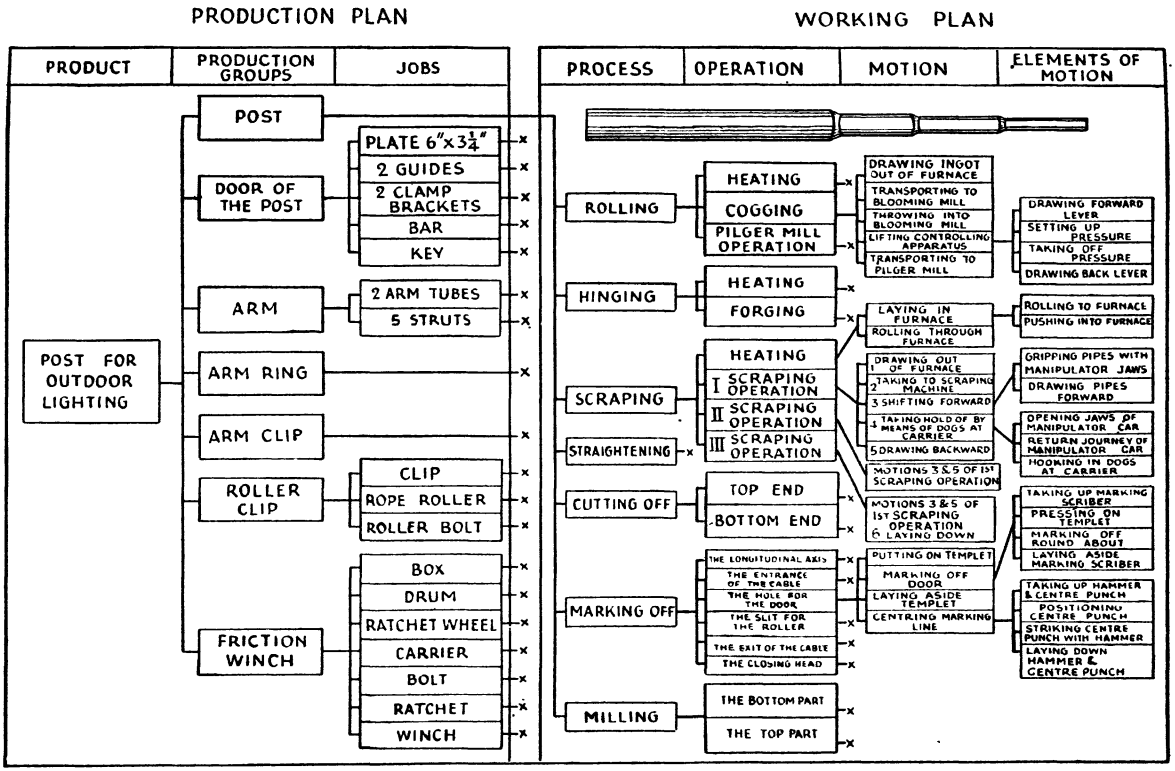


Fig. 2. Production Plan and Working Plan of a Standard for Electric Lighting

or measurable action of a worker in the course of production or preparation of production, consisting of a single complete movement. (Perhaps it is as well to draw the reader's attention to the fact that in this last definition the words "observable or measurable" have to be understood as meaning "observable and measurable by methods practicable in a workshop," and do not refer to methods or instruments available to a scientific laboratory.) It will be apparent that the motion and motion elements referred to in these explanations are those of workers and not those of machines. The other terms can be used equally well for machine or for hand work.

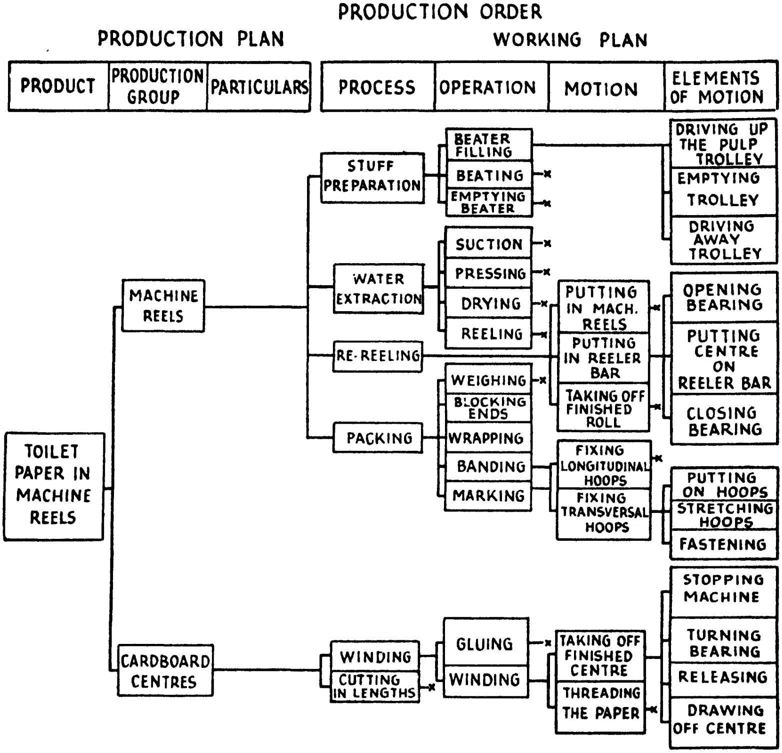


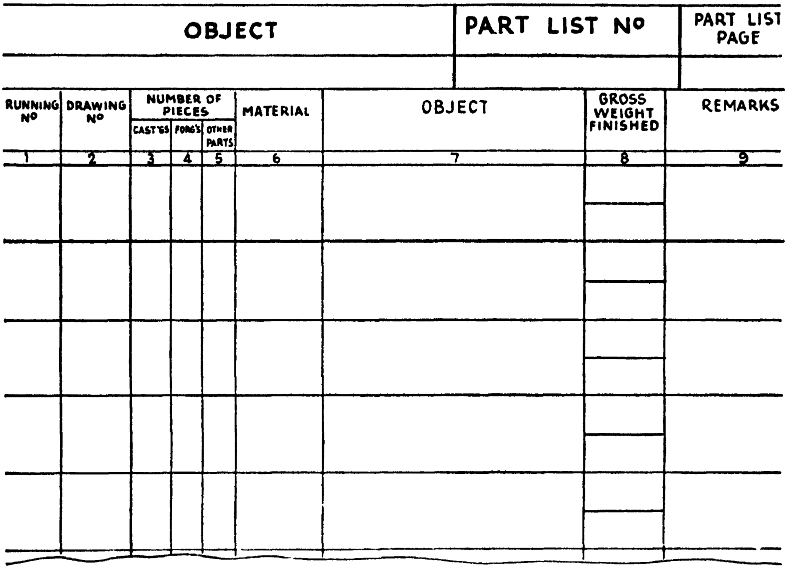
FIG. 3. PRODUCTION PLAN AND WORKING PLAN OF A TOILET ROLL

CHAPTER XV

THE PRODUCTION PLAN AND THE WORKING PLAN

Now after considering the Order Department and the Part List Department, the foundations can be said to have been laid, and the above section on the analysis of work has explained the nomenclature to be used in the following chapters. Therefore we can now proceed to what can be called the "preparation of work" in the proper sense of the word. At this point we must pass from the general to the particular, from following broad lines of development to following the practical processes and operations which each part has to pass through before it goes as a manufactured part to the assembly shop when the final product is built up from the many individual parts given in the part list. This method must be followed irrespective of whether individual, batch or mass production is in question. Naturally the more a process is repeated, or even carried on continuously, the more thoroughly all details have to be considered, worked through and settled. For it would be uneconomic to spend the same time and therefore the same costs in preparing for jobs which occur only once or are repeated only after long intervals and are done under completely changed working conditions, as in preparing for large batch production or even mass production where the expenditure for this work happening but once can be distributed over a large number of orders. It must, however, be considered completely wrong to conclude from these obvious facts that on individual production this preparation of work, i.e. the setting up of a working plan, can be completely omitted. This would merely be leaving the final success to chance, or at least shifting this work from those who are trained and equipped to do it on to the shoulders of foremen and workers who have to do it in addition to their proper work.

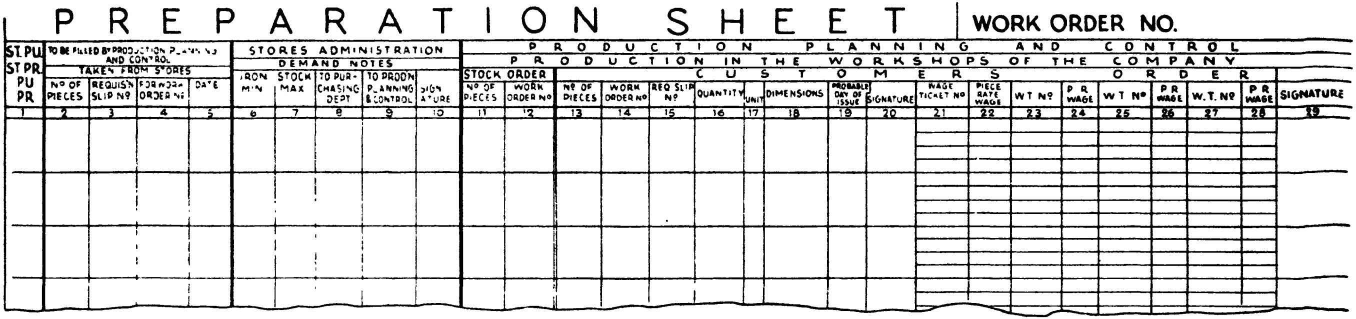
It is outside the scope of this book to go into details, to explain methods of solving the problems in question for particular cases, or even to describe the expedients and instruments which may be used, such as the printed forms; the large notice boards of wood or metal to which indicators can be fixed in any position so that charts, sometimes called "loading charts," can be made of the movement of work from machine to machine or from one place of work to another, so allowing these operations to be followed and governed from a "control room" ; the writing, calculating and sorting machines; the "symbolism," i.e. the abbreviations used to indicate type of work or operations in order to obtain a uniform and clear "shorthand" to reduce writing work. All this system and organization is good as it stands and even necessary, if the work is to be done *economically*, but it does not contain the essence of the matter. To describe one such system in detail would give only one single way of organizing an office, and might in fact obscure the scores of other ways possible. Office organization can easily be made too important and become an end in itself, when it should be only an expedient, a means to an end; where an expedient becomes an end in itself there is a very definite termination to any economy. To give only one example—in the case of a comparatively complicated article, production may be organized and controlled by the use of various graphs and charts. If these are not kept up to date they will gradually lag behind actual production. Since in such a case machines and workers cannot be left unoccupied, the habit slowly grows of allowing the workshops themselves to decide what is to be done, and the charts and graphs, instead of guiding and controlling, merely reflect the progress in the shops. Anyone who has



OBJECT	PART LIST No	PART LIST PAGE

RUNNING No	DRAWING No	NUMBER OF PIECES			MATERIAL	OBJECT	GROSS WEIGHT FINISHED	REMARKS
		CAST'GS	FORG'S	OTHER PARTS				
1	2	3	4	5	6	7	8	9

FIG. 4. PART LIST



PREPARATION SHEET | WORK ORDER NO.

ST PU ST PR PU PR	TO BE FILLED BY PRODUCTION PLANNING AND CONTROL				STORES ADMINISTRATION					PRODUCTION PLANNING AND CONTROL																		
	TAKEN FROM STORES				DEMAND NOTES					PRODUCTION IN THE WORKSHOPS OF THE COMPANY																		
										STOCK ORDER		CUSTOMERS										ORDER						
	Nº OF PIECES	REQUIS'N SLIP Nº	FOR WORK ORDER Nº	DATE	IRON MIN	STOCK MAX	TO PURCHASING DEPT	TO PRODN PLANNING & CONTROL	SIGNATURE	Nº OF PIECES	WORK ORDER Nº	Nº OF PIECES	WORK ORDER Nº	REQ SLIP Nº	QUANTITY	UNIT	DIMENSIONS	PROBABLE DAY OF ISSUE	SIGNATURE	WAGE TICKET Nº	PIECE RATE WAGE	W T Nº	P R WAGE	W T Nº	P R WAGE	W. T. Nº	P R WAGE	SIGNATURE
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29

FIG. 5. PREPARATION LIST FOR PART LIST

passed through many factories observantly will certainly remember several such inversions where a theoretically correct arrangement for guiding and controlling production had been allowed to become an expensive, and probably inaccurate, method of collecting past history, or, to put it in another way, where the production tail has been allowed to wag the control dog.

If a production plan has to be thought out, it will be expedient, as a preliminary measure, to fix the dates by which the main parts of the work should be finished. From past experience the following method has proved very satisfactory. As the date of delivery of the finished plant, machine, etc., is usually fixed from the first during the sales negotiations, it is best to plan production the reverse way round; that is, to start from this fixed date of delivery to the customer and to estimate first the time required to complete the last part of the work, say the assembly; then, beginning from this date, to estimate the time necessary for that part of the work which immediately precedes the assembly; and so on backwards through the whole order.

The fixing of the main dates is best done in a conference in which participate all those interested in the proper carrying out of the order, such as the managers of Design, Production Planning, Production proper, Stores, Purchasing Department, etc. Somebody from the general management should take the chair, and other important questions concerning the order may also be discussed. Of course, instead of holding this conference it would be quite possible to give responsibility for this planning to one specially suitable person with authority to enforce his decisions, say the manager of the Production Planning Section, who would give his final instructions to each department in writing. Undoubtedly the same results could be achieved in this way, perhaps, even with a saving in time; and possibly mistakes on the part of the manager of Production Planning would, because of the jealousy of the other departments and persons, be quickly found out and criticized. But the psychological value of conference and committee meetings should not be underestimated; everyone who is entitled to participate has the feeling of being personally responsible for the settlement of the order in time and in first-class quality. It is possible, especially if individual production prevails in the works, that these conferences may take place too frequently and may occupy too much of the general management's time. In this case it would be desirable to make somebody, say the manager of Production Planning, the permanent chairman, but the general management should take the chair from time to time and convince themselves that these important discussions are going on in the manner and spirit they desire.

It should be emphasized that the dates fixed in these conferences can only be considered as preliminary. They have to be carefully checked by the measures now to be explained in detail, and any alterations which may be found to be necessary during this scrutiny have to be communicated to all those who were at the original conference.

Having considered the material contained in the preceding chapters—the Order Department, the Part List Department, and the Analysis of Work—it is now possible to turn towards the problem of what has to be done during the preparation of work in the proper sense of the word, i.e. confronted by a real work order, to determine in detail how the work should go on. It is obvious that this job may be divided into two parts, of which the first deals with the material required and the second with the work to be done, this second part being generally known in the works as Process Planning.

PREPARING FOR THE NECESSARY MATERIAL

All instructions about dimensions, quality, and quantity are contained in the part list and from this stage it is only necessary to find the best way of passing on this information to the raw material stores and the workshops. In principle there are two different ways: either the order part list itself is used in one or several copies or special slips are provided, which are either given to Production to be used as requisition slips from the Stores or are given to the Stores in the form of issue slips to Production.

There will be an opportunity to discuss this question later on in detail. Here only one principle needs to be emphasized: if the methods of modern production management are put into operation and the preparation of work is separated from Production proper, then if all the possible advantages of this arrangement are to be obtained all instructions and information concerning the transfer from the Stores to the workshops of the materials actually to be used in manufacture must be strictly controlled and issued from one place only, the Part List Department. Only a person who has himself succeeded in introducing this measure to a works where previously other habits were usual can fully judge what an enormous amount of work is involved in this transformation, and how much caution and tact is required to change over from the old to the new methods if troubles and setbacks are to be avoided. Only such a person, however, can completely appreciate the enormous improvement in all working conditions which is achieved if this method is carried through thoroughly.

CHAPTER XVI

THE PRODUCTION PLAN AND THE WORKING PLAN (*contd.*)

PROCESS PLANNING

PROCESS Planning can be defined as consisting in the predetermination of the method to be used in manufacturing the product concerned, in arranging the necessary plant, in designing and providing the special equipment required, in selecting the sequence of processes and operations, and in determining their working times. Not everyone will agree with this definition in every respect, and some may consider it not exhaustive enough while others may think it too comprehensive; it can, however, be considered as a guide to what is generally understood by this term in practice.

By including in the definition of process planning the words "arranging the necessary plant" a fundamental consideration has been introduced. Process planning has to start by considering whether the plant has to be built up as something quite new for a strictly defined production of a special product, and for this product alone; whether it is intended to obtain an "all-round plant" for various products which may have some similarity to each other but which are different in size, type, and to some extent also in purpose; or whether the plant exists already and the product whose processes are to be planned has to be produced by means of this plant with as few changes and adaptations as possible. This consideration is to some extent similar to the question, whether the planning is to be for *mass*, *batch*, or *individual* production, and it is well known that like all work of organization, production planning is more difficult the more production differs from mass production and the more it approaches individual or jobbing production. The special equipment required for production may consist not only of special machines built for one special operation on one part, or on parts of similar design only slightly differing in size, but also of special tools, devices, jigs, gauges, etc., designed and built for a special purpose and nearly useless for any other.

In the case of batch production, where the batches have to be repeated from time to time, the question of *the "right" quantity to be produced in one batch* has received great attention and rightly so; but the attempt to develop a formula or formulae by means of which an answer can be "calculated" has largely failed. Experience has shown that the cases where one or other of these formulae can be used in practice are so rare, and the correctness of the final result is so uncertain, that these formulae are better left out of account. It is only necessary to know that the storage of excessive quantities involves the losses which follow excessive investment, and that on the other hand too small quantities bring about the danger of shortage. In steering between these two extremes, there is little but common sense to act as a guide. It is true that the larger the batch becomes the smaller the production costs per piece—the main saving being in setting time—while the amount of interest on the invested capital increases with the size of the batch.

As there will be ample opportunity to come back to these considerations in greater detail, this is all that needs to be said at the moment.

After these general remarks on the task of process planning the special work under this heading may be considered. It can be analysed into—

1. Determination of the kind of manufacture.
2. Determination of the duration of the working time.
3. Fixing of wages.

Determination of the Kind of Manufacture

In simple cases it may be necessary only to note the kind of work—e.g. turning, fitting, riveting, etc.—to be done on the worker's wage papers which are given to him via the foreman, but usually it is desirable to keep a more detailed record of what is done in order to have this information readily available in case of a repetition of the same work, as well as to be able to answer inquiries, to possess a basis for calculation, etc. Probably a card or sheet will be developed for each individual part, on which all technical particulars will be put down and which will give exhaustive information about the process of manufacture, the devices used, such as fixtures, tools, gauges, the speed and feed of the machine tool, the calculated working time for production; in short, all details necessary for complete knowledge of the process. In the case of mass production, and even of large batch production, the main data on these cards or sheets are in addition recorded in the form of a plan or chart, including possibly drawings or sketches of the part. Of course there is no technical reason why this should not also be done in the case of individual or jobbing production—but it will generally be omitted for economic reasons.

These charts or sheets will give in this way a true picture of the manufacturing process, and the minuteness of detail shown in them, i.e. the work put into them, will always depend on the economic advantages to be derived from such an arrangement, either immediately or at later repetitions of the same order; for the saving made by such charts must always outweigh the costs of producing them.

In this connexion there arises the much disputed question whether *instruction cards* should be evolved and given to the operator, and, if issued, how much detail they should carry. In the literature on the subject, especially that dealing with the work of F. W. Taylor, very detailed suggestions on this point can be found, but a very cautious attitude should be adopted when considering this subject. In any case the problem is important enough to warrant discussion at some length. Many would feel that to go into as much detail as Taylor proposes is taking the principle of issuing instructions too far; others again may well think that even greater detail is needed. Such diversity of opinion can be explained only by reference to the prevailing conditions and the kind of labour employed.

Experience and common sense both teach that, generally speaking, work which has to be performed by skilled artisans such as tool-makers, sheet-metal workers, copper-smiths, boiler-makers, etc., should not be accompanied by wearisome detailed instructions. These men have a tradition of skill and experience which merits and requires full scope for its application and development. They would quite rightly resent this interference with their craft. The work reserved for this class of worker is usually small in quantity or especially intricate in nature, and it is neither economic nor desirable to give over-detailed instructions.

At the other extreme, where intricate work of a repetitive nature is performed by unskilled and semi-skilled workers, but where quantities, though large, are not large enough to permit of constant employment at the same task for any considerable length of time, conditions are entirely different, and although the work as such may often be interesting, there is no tradition of skill and experience, and the main interest is usually to make the best of the incentive which is normally fixed on this kind of work. Very detailed instructions are commonly required in such cases, to define clearly the task to be performed, the equipment to be used, the quality to be maintained, the time and price allowed, etc. In fact, the instructions serve as a contract between the worker and the management and help to create better relations by providing a written definition of each job, accessible to all, which can act as a basis for any discussions or claims that may arise.

It must be borne in mind that in between these two extremes lies a whole range of possible grading of the degree of process planning which can be applied; and it is the duty of the person responsible to determine and to issue just the correct amount of "instructions," according to the conditions prevailing in the particular case.

Another point which must be considered is of special importance. It has been mentioned that it is necessary to note in the working plan all *devices* necessary for the actual manufacture, such as fixtures, tools, gauges, etc. This is connected with a question which is still very much disputed: Who should be the man to decide these things, their design, production and use? There may still be works, especially small ones with jobbing production, where this decision is left completely to the workshops, where the foreman or even the operator is the real designer and the form of the device is perhaps adapted to suit the material at hand or even on the scrap-heap; on the finished fixture or jig this makeshift origin and structure can frequently be detected. The workshops also take care of tools and gauges, using the latter only where they think them necessary.

This state of affairs has, of course, many disadvantages and therefore other works have developed a tool-drawing office, which forms a part of production and specializes in designing tools, fixtures, devices, gauges, etc. Differences of opinion with the main Design drawing office are very often the consequence, as the tools drawing office criticizes the main drawing office for producing designs needing unnecessarily expensive devices and tools to produce them. The main drawing office often takes up the attitude that it has nothing to do with production problems and that the design once fixed should be carried out whatever the cost. Reasonable designers who could not shut their eyes to these production objections therefore asked that the main drawing office should have assigned to it not only the development and design of products but also that of devices, fixtures, jigs, etc., as well as the selection and forming of the tools and gauges.

It cannot be denied that in this way the original state of tension was largely removed. On the other hand, the close connexion with production which is so important in these matters was liable to be only too easily lost, for it is most unlikely that the designer of the workpiece would be so familiar with all details of production that he would also be capable of designing the best tools and devices. It is in fact hardly possible to find a solution satisfactory in every respect. Experience seems to show that it is best to regard this function as falling somewhere between the design and the production of the saleable goods, i.e. to arrange for, apart from the main drawing office, a drawing office for fixtures, tools, and gauges, which is a part of the Production Planning Section. This arrangement can be further recommended since the principles which have to be followed when designing fixtures and tools are different from those for designing products. The more this range of devices, fixtures, etc., gains in importance to production the more the great difference in principles of design is appreciated. A sign of this fact is the appearance in publications of "instructions for design of devices, fixtures, etc.," besides the old "design of workpieces, machine parts, etc.," and of the advertisements which refer to vacancies for designers of tools, gauges, and appliances of many different kinds.

If it is decided to put the design of jigs and tools under the control of the Production Planning Section, such a department should also be responsible for all devices, fixtures and gauges, and frequently for patterns as well. It is fairly obvious that this should also have the duty of making certain that all jigs and tools, etc., are ready in time for orders to be completed by their promised delivery dates. In a small works it would be usual for all these jobs to be done by one person, but if as the works grow larger these tasks also increase, the development of special departments is natural.

After they are made, the jigs, tools, fixtures, gauges, etc., are usually put into store. These stores can be organized in various ways, and jigs and tools issued from stores on instructions similar to those for delivery of material, to which detailed reference will be made later on. It should be noted, however, that the administration of the jig and tool store should be kept separate from the stores for production material; it should also be subordinate to the Production Planning Section. There is, of course, an external similarity between the work in both kinds of stores, but because of the differences in the nature of the things to be stored there is in fact such a difference in the work to be done in each case that this administrative separation is objectively justified.

These explanations are sufficient with respect to the first part of process planning, to which the heading"Determination of the Kind of Manufacture" has been given. To go into more detail would involve dealing technically with the various branches of industry and would therefore be clearly outside the scope of this book. But it should already be clear to the reader from what has been given under the first heading that within the Process Planning Department the people entrusted with this job must be highly-trained engineers, familiar with the production problems of the class of work done in the particular plant for which they have to do the process planning.

Determination of the Duration of the Working Time

The discussion now turns to a very important, possibly even the most important, problem that has to be solved in industrial administration and management. Here it is touched on in connexion with finding out what is a "fair wage." On examination it will be found that determining a "fair wage" is only one of the many facets of this question, all of which influence factory life. Beneath the seemingly simple heading lurks indeed what is implied by the term "time study," which during the past quarter of a century has caused not only a flood of publications but also a conflict of opinion that has perhaps been unequalled by anything else in factory management. In these circumstances it may be desirable to consider the problem from a somewhat broader aspect and first of all to make some preliminary and more general remarks about time studies.

An old adage says "time is money," but it would be better to say "time is more than money," for money lost can be recovered but time lost is lost irrevocably. Do we act in practical life in accordance with this fact, however? In particular, is the industrial employee always conscious of this fact? A walk through most of our factories must convince us that this most valuable commodity, time, is idled away and neglected in a manner that shows that only a few people have a real understanding of what they are actually doing. Time study is important in that it sharpens the consciousness of what time really means in all parts of the works, not only in the shops but in the offices too. Engineers know that power and material are indestructible, but that time is the most transitory element of all that man calls his fortune, is forgotten only too easily.

What does the term Time Study actually mean at present? Time studies have changed since the days of Frederick W. Taylor, that great engineer who first made such studies systematically more than half a century ago. The idea "time" has given way to the idea "work done in a certain time"; instead of "time study" it would be better to speak of "work and time study," or perhaps, following the example of the Americans, "method study and time study."

This opportunity may also be used to explain a third term, "motion study," dealing with the individual motions of the human body during manual work. The official definition given by the Ministry of Aircraft Production was as follows: Motion study is the scientific investigation of the movement involved in the performance of any piece of work and the development of methods which eliminate unnecessary movement and conserve energy, time, and materials.[1]

The time study—to use this short term in the following discussion for all three kinds of studies together—is not, as the layman may believe, a pure determination of the time needed to perform certain work. It is—

(1) An analysis of the work as it is done, perhaps according to the scheme explained in an earlier chapter "Production Planning." The individual processes and operations are examined and analysed as is thought desirable and the various times required are measured, usually by means of stop-watches.

(2) A rationalization. Any improvement in the method of working suggested by the information obtained is carried out, with the elimination as far as possible of delays and lost times and of wasted and unnecessary motions, and with any alteration to machines or tools which may be required, thus speeding up the operations without undue strain to operators or machinery.

(3) A time study proper, measuring the times necessary for the improved or rationalized process.

(4) Analysis and criticism of the study under (3) with a view to investigating the possibility of further improvements and, if necessary, separation of unsuitable or doubtful figures.

(5) Further utilization of the results for future work. Preparation of a system of tables from the results of (4) above, to be used for all purposes for which the results of this research work may be required and entering in them, from the observation sheets, the relevant figures of working times obtained during the time study proper; if necessary, testing and proving these figures by further studies.

It is valuable, although not necessary, to standardize the nomenclature of the different parts of work and time. The nomenclature for work has been already dealt with, that for time will appear in the future course of these explanations. The standardization of nomenclature helps to avoid mistakes and makes discussion and instructions easier in an individual undertaking, while, if widely adopted, it facilitates the exchange of employees from one works to another for the benefit of the community.

Time studies can, as already mentioned, be used as a help towards improving production. The improvements may be distinguished as those that require or do not require investment of new capital. In both cases the investigation of the present state of affairs from all possible aspects is important. As the process of production is mostly a combination of work done by (1) man on (2) material by (3) means of machines or tools, these three points of view should be taken into account. Questions of organization, technology, engineering practice on the machines and tools and their maintenance, and of the best manner of treating and leading men, etc., must be answered. If as a result of the investigation it is found necessary to buy new machines or new tools, to enlarge the shops or even to build completely new ones, the basic facts and figures can be developed according to these investigations and can form the foundation of inquiries for supplies of new equipment. Often the result is only small individual improvements in production, but added together they may finally give such an increase of profit, and an improvement of the whole atmosphere and spirit in the shop as astonishes even the investigators themselves.

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[1] *An Introduction to the Theory and Application of Motion Study*, by A. G. Shaw (H.M. Stationery Office, London, 1945).

Of course the necessity for these improvements is usually evident as soon as method, time, or motion studies are made. But if it is asked why they are not carried out more often, no answer or only an evasive one is given. It is only when systematic studies give a measure of the damage done by the continuous toleration of old and bad habits or arrangements that actual remedy takes place. Innumerable examples could be given of such cases. We might mention here the rational arranging of the working programme of a plant, e.g. avoiding frequent changing of tools; the improvement of sharpening of lathe tools, saws, etc., by the organization of a common tool room for a number of workshops; making out a general transport time-table if the works are large; the simultaneous use of both hands, where previously the operators worked with one hand only or considered the other at best as a help, etc.

The time study as the *basis of a fair wage system* has already been mentioned, but this point needs to be expanded because of its supreme importance.

Theoretically there cannot be a fair wage system so long as the work of men cannot be measured in the same way as weight, dimensions, or temperature, etc., can be measured. It is known, however, that no such measure of human labour exists at present and that it will not be available, if ever, until physiological and psychological science is much further advanced than it is to-day. Therefore we have to be content with the nearest approach to measuring human labour, and that is to measure the working time, provided that the measuring process is really a comparison of various quantities of human labour of the same kind with each other. From these considerations it follows that time studies can give only approximate results, but the approximation has proved sufficiently correct for practical purposes. Nevertheless it is useful for the time-study engineer to keep this approximation in mind to prevent him from becoming conceited and dictatorial.

The methods of determining working times are generally classified into (1) estimation, (2) calculation, (3) time studies proper, and (4) comparison. They may be shortly characterized as follows—

(1) Estimation is the oldest and simplest method and is, in fact, often used unconsciously by those who even to-day deny the importance of the modern determination of working time. Its accuracy depends on the experience of the estimator and the care with which he does his work. The exclusive use of this method can be justified only in simple cases, and only then by first analysing the job into parts which may be estimated separately. The old method of estimating in overall times or according to some rule of thumb must be condemned in all circumstances.

(2) Calculation is possible only for the main process time on machines. Special mathematical formulae have to be developed for each kind of machine, and usually contain factors depending on the quality of the material, the tool, and the dimensions of the workpiece.

(3) The time study proper is already characterized sufficiently. It is only necessary to add that the accuracy with which this method must be carried out varies considerably according to the circumstances in which the work investigated takes place. It is not true that the time-study engineer works always in tenths or hundredths of minutes; he must possess what one may call "percentage thinking," a real sense of proportion, and must use common sense in applying the method.

(4) Comparison is not a fourth method in the strict sense of the word, but a combination and extension of the three other methods in collecting and arranging working times as found by them, with a view to finding out by interpolation the time required for manufacturing similar articles which differ in size.

If we remember—what can be considered to-day as common knowledge—that the value of any kind of product or saleable goods depends on the amount of man's labour contained in it, it is not astonishing that time, one of the most important factors in the efforts to find a practical measure, is seen to be more and more a leading characteristic of modern *industrial accounts.* It is only necessary to remember the role that standard data play, and that it is almost impossible to obtain reliable standards without time studies of some kind, and it will be realized that actually industrial accounts cannot give a real picture of the building up of costs without the use of this auxiliary. Amongst the uses to which these standards are put may be enumerated: determination of effective capacity of the shops, labour, cost control, and the comparison between standard and actual overhead costs. There will be ample opportunity later in this book to point out the importance of accurate time studies in connexion with industrial accounts. These hints may therefore be sufficient for the moment; they are given in this place only to complete the survey of the usefulness of time studies generally.

The last aspect to which attention should be drawn is the connexion of time-study work with matters of *industrial psychology*. Knowledge in this respect has brought about a great improvement in the attitude of modern management. It is, however, essential that the man who wishes to carry out this work in the right manner should recognize the connexion between the work to be done and the human being who has to do it. Moreover, in technically well-organized undertakings considerable differences between individual places of work and between working methods for the same job can be found, resulting in different levels of success in carrying it out; it has to be investigated why this is so. There may be many reasons for these differences, but only those based on the different individualities of the workers, which cannot and should not be suppressed, will be justified. Suitable methods of training should be evolved, both to raise the willingness to work and to remove any disharmony amongst the workers. Actually the variation in the performance of human beings is much greater than is usually supposed. Practice in modern workshops helps to hide this fact, but cannot eliminate it. It is necessary to find out how far an application of the methods of modern psychology may help to show the most practical way of carrying out this work, without doing any harm to the personality of the worker. Here may be mentioned such methods, amongst others, as the analysis of occupation or trade, improving the arrangement of the work-places, the development of vocational tests, training after starting work, and supplementary and practical instructions later on. All these methods can best be based on careful method, or time, and, especially, motion studies, arranged for the special purpose in question.

Looking back to the various items in this survey of time study—to use this short expression as comprehending all three types of studies—it will be recognized that in practical life it is almost impossible to treat improvement of production, a fair wage system, help in industrial accounts, application of industrial psychology, etc., in separate watertight compartments, for these branches of industrial economics are all closely connected with each other. Whilst it may be possible to treat them separately in a general theoretical survey, in the shops they must be combined, all the different aspects be considered simultaneously, and the best compromise between them must be found. Only too often they make conflicting demands, and of all possible solutions the practical optimum has to be selected.

If these investigations are carried out in the right spirit, correctly and not in an exaggerated manner, showing the way without presumption and with fairness to all concerned, they can develop into a very useful intermediary between the different interests and assist in creating that spirit of co-operation in the firm which is and will always be the first condition for real success and is therefore an important asset in an undertaking, although it cannot be shown in £ s. d. in the balance sheet. It should, however, be expressly added that these studies are nothing but tools, and that like other tools, when used in a wrong or exaggerated way, or without due consideration of industrial psychology and economic principles, they can be dangerous and do more harm than good; they are no panacea and can become a remedy only when applied in the right way and place at the right time by the right man.

In passing we may mention one question which has been the subject of vigorous dispute during the past ten years, ever since motion studies have been in common use in this country. Should there be an almost complete separation between method and time studies on the one hand and motion studies on the other, so that, besides the time-study engineer, as we increasingly find him in well-organized modern works, a new profession, that of a motion-study engineer, should be introduced? It is the author's considered opinion, based on his experience in industrial works, that by this step a dangerous path in the direction of over-specialization would be taken. These studies may be developed by research workers and scientists specializing in one of the two kinds of study, but their practical application in the works should be the responsibility of the same person, as otherwise friction is unavoidable. Therefore separate courses for developing time-study and motion-study engineers cannot be recommended.

A few remarks may be added on how to use method, time and motion studies as a basis for a fair wage system in order to resume the course of explaining the job of process planning within the organization of an industrial works. The question was how to determine the duration of the working time of a process. Of course it is impossible to give here all the details of the work of a time-study engineer; only the general outlines of his work can be given and it can be done in many different ways. Here only one way, which has been proved successful in various branches of industry and in a large number of industrial works, is described; it is simple and easily understood by people who have a good knowledge of and training in production engineering, and who can be successful in their career if they possess common sense in addition to the necessary qualities of character such as tact, gift of observation, easy association with other people of various social standings, etc. No outside specialist is necessary for the introduction of this method, as the actual figures cannot be taken from other undertakings but must be developed at the works where they are to be applied to suit its special working conditions; it would also be a mistake to believe it to be sufficient to introduce the "system" once and for all and then let it go on its own way. Like all methods of organization it needs continuous and careful observation and development.

The *tools used by the time-study engineer* are the ten-inch slide rule, the accuracy of which is quite sufficient for his work, and a stop-watch. Other useful instruments are a revolution counter and a tachometer which can be adapted for reading revolutions per minute or feet per minute. Printed or otherwise duplicated forms are best developed by the time-study engineer himself to suit the working conditions of the firm. The tables of figures and the graphs which are needed to make the best use of time study should originate from his experience in his own works in the shops and should not be taken from publications. Published figures may be quite good as a guide but can never be used in practice without careful checking to see whether they are suited to the working conditions of the firm. Far too many circumstances influence these figures: the kind of material of the workpiece and tool; the degree of accuracy and quality of production; the area of the cross-section of the cut when turning, milling, or drilling; the size and stability of the workpiece; strength, rigidity, age, and state of repair of the machine, etc.

His observations in the shops should be carried out in full agreement with the person observed and under no circumstances behind his back, as sometimes happened when time-study work was first introduced. Attempts at "secret" timing are always found out, only create suspicion, and must be discouraged by all possible means.

Of course there is an enormous amount of work involved in finding out all the important data—data which must be known in order to know the working of a machine thoroughly—for all the machine tools in the shop. It is best to build up a card index with one card for each machine with all the data, commercial as well as technical, on it, which can then be a basis for the determination of the working time on these machines. It cannot be denied that this job will cause much work and considerable costs, but generally it can be said to pay, for it is useful for other things than the determination of the working time. It shows, for instance, where slight defects have occurred in the course of time and what can be remedied at comparatively little cost; or it may even reveal for the first time the actual capacity of a machine and it may be discovered that its possibilities have not been fully utilized in the past. Using this inventory as a basis, a thorough rationalization can be carried out. First of all the performance of machines of the same kind and size should be compared. If certain of them fall below the level of the best, then the reason, if it is not already obvious from the collected data, must be found out. Perhaps only a slight alteration in the speed is required, or, if machines are each fitted with a separate motor, the motor may be too small for the machine. If line-shafts with belt drives are used—and they are becoming less common—then they should be checked for speed and to see if, when all machines are working, they can really transmit the power required. These and other comparatively minor points may all be the cause of lost time and lost production.

Next, machines of similar size and similar kind should be grouped together so that average performance figures may be used for the group, so simplifying planning and the meeting of emergencies, such as rush orders or breakdown of machines. The determination of the working time obviously penetrates deeply into all problems of production management. Its duration is only one important aspect; it is as important to find out whether the sequence of operations as fixed is really the best under the working conditions, whether the organization is really working as intended, whether material, tools, devices are always available in the right quantity and quality at the right time and in the right place, or in other words whether rationalization has attained the highest possible degree of efficiency.

Turning to the question of how the determination of working time should be actually carried out in practice it must be stated, as so often in problems of organization, that *there are many different ways leading to this end.* The simplest, and therefore the easiest to be understood, should be used. The method described below is the one which the author has found best in practice because it is simple, and any worker with ordinary common sense can understand it. It has proved flexible enough to be adapted to any industry, although it was originally developed for engineering, and it has been applied with equal success to mass production, large and small batch production, and to individual or jobbing production.

In the same way as the determination of the kind of work has been preceded by an analysis of the work, the determination of the working time may be introduced by the analysis of this time as represented by Fig. 6. The various terms may be defined as follows. The work consists of the production of a batch of *n* pieces. The time is divided into *piece time*, occurring *n* times, and into *change-over time*, which happens only *once* for the batch; for this is the time for the preparation of the work, work-place, machine tools, materials and workpiece before starting the job proper, and, if it is necessary, for the restoration of any or all of these to their original condition; in any case it includes any cleaning up that may have to be done in the course of a process or operation. The division of the working time of a job into change-over time and piece time is of fundamental importance, because they are of completely different character and should therefore generally be dealt with in a different manner when the question of their determination arises. For the change-over time a more superficial method may be justified; the piece time requires increasingly refined methods, the larger the number *n* of the pieces is. For piece-rate wages it is necessary to develop two separated piece rates for both times, as the adding together of these two times—unfortunately so usual in practice—may easily lead to the "good and bad piece rates" which cause so much trouble in the shops. This may best be explained by the following example.

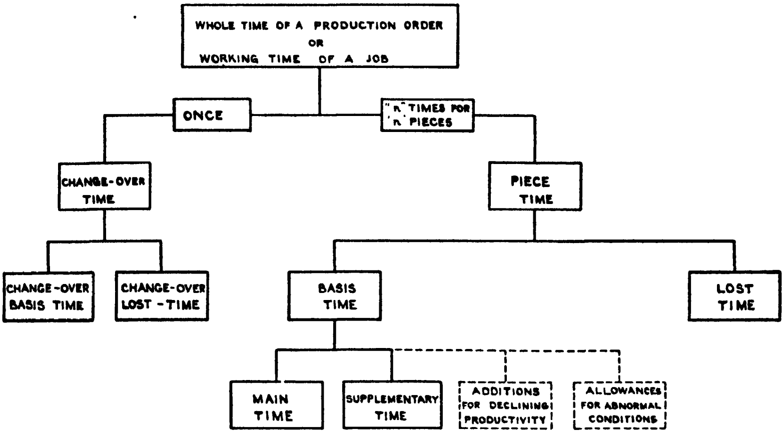

FIG. 6. ANALYSIS OF TIME

A certain operation has a change-over time of 30 minutes and a piece time of 1 minute. The total working is therefore—

In the case of a batch of 30:
Change-over time 30 minutes
Piece time 30 × 1 = 30 „
Total working time 60 „
Working time per piece = $\frac{60}{30}$
2 minutes each

In the case of a batch of 300:
Change-over time 30 minutes
Piece time 300 × 1 = 300 „
Total working time 330 „
Working time per piece = $\frac{330}{300}$
1·1 minutes each

If a piece rate of 2 minutes is chosen, it is a "fair rate" for a batch of 30, but a "good rate" for a batch of 300. Alternatively, if a piece rate of 1·1 minutes is chosen it is a "fair rate" for a batch of 300 but a "bad rate" for a batch of 30.

Lost times are times lost or dissipated in activities or delays that have no designed or intended connexion with the simple production process. They need to be taken into account in the determination of working time only if they cause decrease of productivity. Lost times can never become zero as that would be against human nature, but it should be the duty of the time-study engineer to decrease the amount of lost time so far as humanly possible. It is customary to express it in percentage of the corresponding basis time and to use the same percentage for the change-over time and the piece time in order to simplify the calculation.

The piece time is the time between the beginning and the end of a process on one and the same piece. In some cases it is necessary to divide the basis time into two parts, the *main* time and the *supplementary* time. The first is that part of the basis time in which direct progress in the completion of the works order is made, e.g. in the turning process it is the actual turning, removing chips from the workpiece; the second part is regularly necessary, but only indirectly affects the progress of the work, e.g. the clamping of the workpiece in the turning process. This subdivision is used only if the methods of determination of main and supplementary time differ, or if it is desired to consider the supplementary work especially for the purpose of reducing it.

The *additions for declining productivity* are required only if the nature of the work is such that this decline takes place, e.g. if unusual fatigue or other physical or mental strain is connected with the work. It is the duty of the time-study engineer—and certainly a difficult duty—to find out whether these additions are necessary for the job under consideration or whether they could perhaps be eliminated by altering the job in some way. Usually special investigations are necessary before this question can be answered finally.

It is obvious that predetermined times must be altered if the working conditions differ considerably from those anticipated, e.g. when another quality of material has to be used because the one intended for the workpiece or the tool is not in store, etc., i.e. *allowances must be made for abnormal working conditions.*

As may be seen from these explanations, these last two increases of the working time, the additions for declining productivity and the allowances for abnormal conditions, are of a different nature from those for lost time. They can disappear completely—as they do in normal cases—while lost time never can be completely eliminated, although it may be possible to reduce it to a comparatively small amount.

These explanations may be sufficient to give to the reader an idea of how to analyse with or without the help of time studies the times which occur in the shops and which, as already mentioned, should be systematically collected in tables and graphs, in order that it may be possible either to put together new piece rates by the so-called "synthetic method" or to determine the loading of the shop, etc. To go still more into detail would be outside the scope of this book; if the reader wants more detailed information he must be referred to the considerable special literature on the subject.

Fixing of the Wages

What is now to be discussed are fundamental principles and conditions as they should occur ideally but as they will rarely be found in present industrial practice. They can therefore be considered not as a guide to present conditions but rather as aids to understand the issues involved in the fixing of rates; they are rather a reflection of the author's opinion on how it would be possible to come to a simple and clear understanding for fixing rates, than a description of what actually happens in practice. There is such confusion in this important sphere that it is almost impossible to disentangle it and to develop general rules and principles which could afford some guidance for actual practice.

Further it must be emphasized that the following chapters do not deal with the complications brought about by training schemes, or with those cases where apprentices or trainees are employed in the production departments. The selection of the correct worker for the job is of primary importance, and it is assumed that this has been done in all the examples described.

The Relation Between Time and Wages

It has already been mentioned that a close connexion exists between time and wages. As a matter of fact no fair wages can be fixed without taking into account the working time. The final gross wages, from which the net earnings of the workers are derived by subtracting the usual deductions, are always a product of time and a money rate.

Known as these facts are, it is useful to recall them to mind as unfortunately there is very often in practice a mingling of the two factors, which has done and is still doing much harm. Even if in special cases it is not possible to keep the two factors strictly separate, it cannot be too strongly recommended that, at least in theory, it should be done as long as possible. Only in this way can the necessary clarity of ideas be obtained and a change of working conditions be correctly reflected in a corresponding change in the wages. What this means may perhaps best be illustrated by an example.

It is very often asked: Is it possible to give more than one answer when determining the working time for a given job in a given works? In other words: Can more than one working time be correct in circumstances such that the job can be given sometimes to skilled, sometimes to semi-skilled workers, sometimes to youths and sometimes to adults, sometimes to male and sometimes to female labour; i.e. should the working time be different for each class of labour? This question should be answered by a decisive "No." If one takes up the opposite point of view one cuts away the ground from under one's feet. Time is fortunately one of the few ideas which have an equal meaning and measure all over the world; an hour is an hour in the western and eastern hemispheres, both north and south of the equator. The work to be considered is clearly determined by its nature, by the kind of process anticipated, by the equipment to be used, and by the general working conditions in the shop in question. The pace of the performance is given by the supposition of an average performance. Difficult as it is to define this last notion and to find it out in practice, it is obvious that it refers to a worker suitable for the job.

It seems to be very questionable whether the differences between the groups of workers mentioned above, with regard to their pace of performance, are as outstanding as is generally presumed. This fact was recognized in the past, and experience during the war has largely confirmed it. Examples contradicting any preconceived opinions on this point can be given by almost every production engineer.

Moreover, the dividing line between the groups of workers is somewhat uncertain: a youth of 20 years and 11 months may belong to one group and a man of 21 years and 1 month to another. What is the difference between their performances?

Finally, in normal times and under normal working conditions, one tends to allocate a certain type of work to a certain group of workers. We are speaking of typical jobs suitable either for women or for men, and of work for skilled and semi-skilled labour, etc. The time of the average performance will always be developed under the tacit supposition that persons of the appropriate group are engaged on the work.

All this does not mean that these groups must under all circumstances be paid the same wages for the same work. On the contrary, differences can easily be introduced into the calculation by different money factors, e.g. different hourly rates, which are at present usual in practice and are to a large extent embodied in the agreements between employers' federations and trade unions.

This leads to another proposition that has proved very useful in many cases but has not yet found general consent in this country. In the case of a wage system, where a clear separation of time- and money-factor is possible, as for instance in the piece-work system, should not the *rate* be given to the worker *in time* instead of *in money*, as was and still is, usual in many cases? Experience has shown that time rates have the following advantages provided the time is the time of the average performance: the worker can compare his actual working time by his own watch or by the clock in the shop directly with the time expected from him by the office which is finally responsible for the calculation of his earnings. He knows at any moment whether he is in advance or in arrears of what is expected. Further, disputes about money, sometimes very heated and always irritating, can be out of the workshops and are replaced by disputes about times, which can finally—if there is no other way—be settled by demonstration. A further advantage of the piece-work rate expressed in time is that these rates do not have to be changed if as a result of negotiations between employers' federations and trade unions the money factor is altered. To give a simple example, one would not say to the worker, "You have to deliver thirty pieces at twopence per piece," but "We allow you eight minutes per piece at the rate fixed for piece workers of your kind by agreement between the employers' federation and the trade unions."

As soon as the initial difficulties connected with all new methods introduced into the shops are overcome, all the advantages explained above will gradually appear. Moreover—and this is perhaps the most important factor—a favourable change in atmosphere in the shops will take place, if this transition from the money piece-work price to the time allowance has been done carefully and correctly. Sometimes the objection to this measure is that the workers would be opposed to the change and would suspect that the opportunity would be used to lower the rates and thus to force them to work harder if they wanted to obtain the old level of earnings. It is a test of their confidence in the management whether this suspicion can or cannot be overcome. When, however, the initial aversion has been overcome, it is astonishing how quickly the workers become familiar with the new method. They are soon saying, for example: "Last week I earned seventy minutes per hour," etc., i.e. they are *thinking in time*, with the well-known psychological effect that they will appreciate its value and regret its waste. This favourable impression, by the way, is not limited to the workers. It affects next those members of the staff who are in constant contact with the work in the shops, and to some degree is bound also to spread to other groups of staff members, who sometimes need it even more than the workers in the shops.

All this is possible only if the time factor has been really kept clear of all influences that are alien to it, such as age, sex, degree of training of the worker who has to be put on the job, or basic rates kept too low so that the intended level of earnings cannot be attained.

The Various Systems of Wages

The time-study engineer, who is asked to do his job with regard to the remuneration of the workers, should be familiar with the system of wages in use in the works. He should not only know the booking methods and the organization of the whole clerical apparatus concerned but should also understand the principles on which the wage system is built up. This book must therefore deal with the various systems of wages at present in use in industry. The subject is to some extent a matter of dispute and that is why an attempt has been made to present as far as possible the opposing views. On the other hand the author has not hesitated to explain his own point of view on disputable points in order to give the reader some guidance, which he may accept or reject according to his opinion or experience.

The best known and most-used wage systems are the fixed hourly rate and the piece-work rate. All others are more or less built up on one of these two or are a combination of them.

The Fixed Hourly Rate

Certainly the oldest wage system is to pay for the time the worker spends in working, or at least in attendance, at his place of work, at a fixed rate per unit of time, say, an hour. Though this system is the oldest it is by no means obsolete. It is in use openly in many cases, and often in a concealed form even where an enthusiatic advocate of other, more "refined," systems may believe he has introduced and established one of them. There was the time when it was the general opinion that the limitation of the fixed hourly-rate system to as few wage earners as possible was a sign of up-to-date organization. A works manager took a pride in having brought down these wages to 10 per cent or even in some cases to 5 per cent of the total pay-roll. The attentive observer of the modern development of industry will find that this view loses more and more ground. There have always been many cases where the nature of the work calls for payment by fixed hourly rates, i.e. where so many unforeseen incidents are possible that the working time cannot be anticipated with sufficient accuracy, as, for instance, with maintenance work or where the quality of the work might suffer by an incentive to increased working speed, as with some types of inspection work. In addition, the more actual manual work is taken from the workers and transferred to the machines, the more the worker ceases to "work" and becomes a supervisor of machinery; the more the plant governs the time and leaves to the worker only the adjustment and regulation of the process, the more should the percentage of time workers grow and that of the payment-by-result workers decrease. Further, in modern industrial works, the work of one shop or department is frequently so dependent on that of another that this very fact provides an incentive to the workers to deliver the semi-finished products needed as raw material in the subsequent shop, to repair the machine or finish the tool or gauge, etc. They know that their fellow-workers are waiting for these things and that they will perhaps experience serious losses if undue delay occurs.

The fixed hourly-rate system has advantages which recommend it to the management, executives, and workers alike. The calculation of the earnings is very simple and can therefore be easily understood by everybody, and the fluctuations in the earnings per week are small. In many cases, however, there are disadvantages which may more than counterbalance these advantages. For instance, the graduation of wages according to the difficulty of the work done is more or less arbitrary, and the value of a job cannot be easily determined, or at least is not fixed beforehand.

Lack of Incentive

The main objection to this system is, however, that it does not contain any incentive to the worker to overcome his "inborn indolence." It may be doubted, but left undecided, whether he requires this incentive more than others who are not usually considered to be in need of it. If the idea behind the demand for payment-by-result systems for industrial workers is that it would be easy to find and introduce such a system, this point of view must certainly be considered as wrong. Nevertheless, the fact remains that the overwhelming opinion of industrial managers is represented by the following quotation from the pamplet *A National Policy for Industry*.[1]

> Industry itself should aim at assuring to every able-bodied citizen engaged in industry and prepared to do an honest week's work such a basis level of wage as would afford a decent standard of life. Every opportunity should be given to supplement this minimum basis wage by the development of payment by results.

Whilst no authoritative statement of the trade unions on this declaration could be found, it is known that in practice they do not object to payment-by-results systems.

If the opinion is maintained that, at least under present living conditions, a special incentive is necessary to interest the industrial worker in the increase of his production, it should not be overlooked that this incentive need not necessarily be of a monetary nature. Much has been published about this problem and the attentive observer must come to the conclusion that the tendency is to put more and more importance on other kinds of incentives. Although there will be opportunity to deal with this problem later on in another connexion, it may be useful to quote at least one of these sources which summarizes the conclusion of a wide investigation as follows—

> All methods intended to stimulate the interest of the worker in increasing his efficiency must necessarily work by showing him that the idea of value and its actual production by the concern are directly connected with his own increased output and with overcoming hindrances which make it difficult for him to achieve a high rate of production. Undoubtedly we can consider only those systems of evaluation which either can be supposed to be based upon human nature, or which seem typical for a group of workers, or which can be transmitted by education and training.
>
> Accordingly, four groups of methods may be distinguished, the first two being based on the inborn human character and the other two on training. They are as follows—
>
> 1. Material incentive: monetary and material security.

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[1] Published 1942, and signed by 120 well-known industrial managers.

2. The best possible organization of the work from the technical as well as the psychological point of view, i.e. removal of anything that might hinder the worker: in other words, proper rationalization.
3. Professional training of the worker to make him "a craftsman conscious of his status."
4. Education of the worker's social and moral personality and of his outlook towards his work.

None of these methods can in practice be used alone. Each individual case must decide which aspect of the problem is most important, what combination of methods should be used and to what extent the possibilities of each may be exploited.[1]

Co-partnership. This opportunity may be used for mentioning another fiercely disputed problem: the participation of the workers in the trading profits, very often termed "co-partnership." The author must confess that he is an opponent of all schemes of this kind which he has met in practice or studied in publications and his reasons for taking this point of view are partly of principle, partly because according to his experience these schemes operate to the advantage of the workers in some cases only and are disappointing in others.

He remembers, for instance, the following cases. In a well-to-do firm it was the custom to pay to employees and workers the share of the profit as a gratis payment which about doubled their income for the month of December and was paid on the 15th of that month. This worked for perhaps six years to everybody's satisfaction. Owing to a change in the business situation, profit disappeared completely and the firm was forced to announce at the 1st of December that the custom of paying the December income twice would have to be abandoned, at least for the current year. What disastrous influence this measure had on the Christmas festivities of the families concerned can easily be imagined. A similar example happened in another firm, where a collective contract had been made with the foreman that a certain percentage of the profit to be distributed should be allocated to the foremen in proportion to their salaries during the year. The works were situated near a small town, where everybody knew of this contract and realized that the foremen of this firm could expect to be paid a considerable sum shortly after the general meeting of the shareholders which occurred during the first weeks of May. The result was that the traders in the small town got into the habit of giving extended credit for such things as, say, clothes, furniture, etc., bought during the year, and sent in their account on the first of May. When the good business years were then followed by meagre and even bad ones owing to no fault of the management but the general business situation, a great number of the foremen were left suddenly in debt which it took them a long time to pay off. It may be said that these examples only show that the participants in these schemes were foolish and should not have anticipated the receipt of money which was not certain. In theory this view is correct but, human nature being as it is, the view in practice is hopelessly wrong.

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[1] Bramesfeld: "What are the Relative Advantages of the Different Methods to be Used to Interest the Worker in the Increase of His Production," 5th International Congress for Scientific Organization of Labour, Amsterdam, 18th to 23rd July, 1932.

The survey given by the chairman of the National Coal Board after the conclusion of the first year of the nationalization of the mines adds up to the following result: This first year shows a loss of £23 millions. As employees are now partners, i.e. will participate in any future profit, they also have to participate in this loss; as it is impossible to make good this loss by increasing the price of coal, which would only mean shifting the loss to the shoulders of the already overburdened taxpayer, the earners of salaries and wages in the coal industry, from the manager down to the simple labourer, have therefore to repay this sum in some way or another. Actually the chairman has not said it in so many words—if he had, the public outcry can be imagined—but it is still a secret how this loss is to be made good without additional burden on the community or repayment in some form by the partners.

If the following figures applying to a typical British industry[1] are a correct average for this industry as a whole, what would be the advantage of distributing even half of the whole paid dividend to the industrial population of salary and wage earners? £1 output is composed of—

	d.
Wages and salaries	88
Raw material	85
Operating expenses	38
Taxation	14
Profits retained in the business	6
Depreciation	5
Dividend	4
	240d.

$$\tfrac{1}{2} \times \tfrac{4}{88} \times 100 = 2\tfrac{1}{4} \text{ per cent}$$

i.e. if the business year closed on 1st January, a man would perhaps receive 45s. per £100 of what he has earned in the past year at about the beginning of April of the next year.

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[1] Given by Mr. W. J. Brown, M.P., in the *Evening Standard*, 9th September, 1948.

Of course these figures are misleading because they are an average, which means that the result would be better in one concern and worse in another.

For anyone who has a small income, fluctuations in this income are almost intolerable if he truly intends to make both ends meet. Those who have the best interests of the industrial workers in mind must be opposed to real partnership for them, for it would mean different payment for the same work without any consideration of the efforts made by the workers; the increase in the income of the workers would be on the average less considerable than they expected because this increase could be paid—if at all—only after a time much too long for it to be felt as a real remuneration for exceptional efforts.

The management and administration of any industrial concern always bears some risk and this risk should be borne by someone who can afford it—the owners of the concern: in privately-owned concerns the shareholders, in nationalized industries the community. If a loss is not covered by reserves built from past profits a loan must be obtained, which means that the loss will be made good in instalments out of future profits, and if a loan is unobtainable the only solutions are either to sell some capital assets or to go into bankruptcy.

Systems of Payment by Results

What does the term "payment by results" really mean? Obviously that the worker is paid not according to the time he is present at his place of work, but according to the work he does during this time. In the fixed hourly-rate system a rate per unit of *time* had to be fixed for each work; now a rate per unit of *work* is necessary to enable each job to be valued, and this is as already shown a problem which must be considered insoluble from a theoretical point of view, as the general measure of human labour is still unknown. In these circumstances nothing remains but to make an approximation to the truth, which should be as close as possible compatible with the purposes for which one is striving. These considerations should be kept well in mind when dealing with all systems of payment by results, for they show that there is no perfect system of this kind in existence, but that every one of these systems represents only a more or less satisfactory compromise.

Many systems of payment by results have been invented, advertised, and used in practice, to be abandoned again and forgotten. It is not intended to describe them all in detail, particularly as they are, to a large extent, of no practical importance. It is, however, useful to understand their fundamentals, especially as it will give greater insight into the nature of the most important and most frequently used system of payment by results, the piece-work system.

All systems can be divided into three groups: the first pays to the worker less than an amount strictly proportionate to the result of his work; the second pays more than this amount; and the third pays, or at least attempts to pay, an amount exactly proportionate to the work done. What is meant by these statements may best be illustrated by Fig. 7, showing the principles of various wage systems,

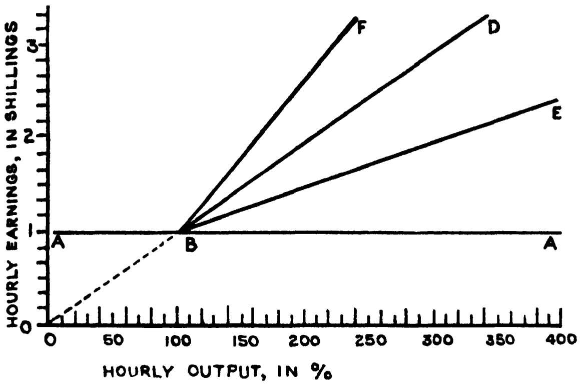

FIG. 7. VARIOUS WAGE SYSTEMS

where the lines *A-B-E*, *A-B-F*, and *A-B-D* represent the three groups respectively, always assuming that a minimum wage *OA*, equal to a fixed hourly rate, is guaranteed as a lower limit of earnings.

As a matter of fact, only the pure piece-rate system can really be called a system of payment by results; for it is the only system where, as the term implies, the payment is directly proportionate to the result. It is, however, usual to use this term also for the other two groups where the payment depends on, without being directly proportionate to, the results.

The Pure Piece-rate System

It will be explained later why this is never applied in practice in the pure form. The system is based on the principle that a price should be fixed in advance per unit of the product concerned and that the worker should be paid according to the number of units he has finished, providing that the quality is acceptable on subsequent inspection. All rejects not due to the worker's faulty labour should be counted in his favour. The principle is simple and sound. If the output is 50 per cent higher than expected the worker earns 50 per cent more than the average taken as the basis for calculation; if the output corresponds only to 80 per cent of that anticipated he earns 20 per cent less than the average.

This simple connexion between earnings and output does not exist in all other systems of payment by results, known as premium, premium bonus, or bonus systems, or under the names of their various inventors. Most of them included in Group 1, and illustrated in Fig. 7 by the line *A-B-E*, do not pay the worker his gross earnings but keep back from him a part, usually a percentage, of what he earns in excess of what he would be paid on a fixed hourly rate. Many reasons have been given for this procedure, but it is doubtful whether any of them can stand a close examination. Here only two of the most usual will be quoted—

(*a*) That the worker is able to earn a margin above the fixed hourly rate is due not only to his own ability and willingness to work but also to the plant and organization provided by the management, who should therefore share adequately in any extra earnings.

This argument neglects the fact that the management already receives the full profit on overheads decreased by any increased output, and the more modern the plant and equipment the greater will be this gain.

(*b*) Owing to the difficulty in fixing a fair price per unit of product and because low prices may cause trouble with the men, it is assumed that prices generally will be too high. Therefore it is thought necessary to reduce the worker's earnings by a deduction from his margin of profit over his fixed hourly rate.

This argument is certainly absurd. It is true that it is difficult to determine a fair piece-work price, but it can never be a just basis for developing a method which systematically withholds from the worker a part of the earnings to which he feels he is entitled. A better solution to the problem would be to try to improve the method of piece-price fixing as far as possible. For the rest the risk contained in the piece-work system has to be taken as long as one believes that the advantages more than outweigh any possible loss.

There may be other reasons, with better justification, for adopting the systems illustrated by the line *A-B-E* of Fig. 7, but the fact remains that it will be very difficult to convince the workers that these methods of wage determination do not withhold from them a part of their earnings. This ill-feeling will in the long run out-balance any compensating advantages which may be offered to them.

Sometimes a wage system is encountered where the margin between the anticipated earnings and the fixed hourly rate increases more quickly than the output; if the output increases 10 per cent the margin increases to 15 per cent; for an increase in output of 20 per cent, the margin becomes 30 per cent, etc. The reason given for this plan is that if the average utilization of plant is about 80 per cent of the possible maximum, the increase from 80 per cent to 85 per cent is easier than that from 85 per cent to 90 per cent, and that again is much easier than that from 90 per cent to 95 per cent, and the nearer to the limit the greater the effort needed to obtain a further increase in plant utilization. It cannot be denied that this deduction is logical; nevertheless, it should not be taken as a guide as it may lead to a danger that should be avoided in all circumstances. One of the objections raised against the piece-rate system—and, of course, to some extent against all incentive wage systems—is that the incentive may drive the workers to overstrain their own capacity for work as well as that of the machinery. While experience has shown that, with few exceptions, this is not the case with the piece-rate system, it is quite possible that it will occur when the impetus given to increased production is stimulated by a still higher degree of incentive. Overstrain of this kind is in the interest neither of the worker nor of the works.

It must be added that the fundamentals of all other systems of payment by results are not so simple as those of the piece-rate system. Moreover, it is not so easy to understand how the final result, i.e. the gross earnings of a worker, is obtained, and the conscientious worker often finds it difficult to follow and verify the calculations made in the Wages Office, and often suspects that he has not been treated as he should be.

The workers have seldom been satisfied by any of these systems, and the clerks in the Wages Office were in most cases glad to see them disappear after a comparatively short time, because of the increase in work and trouble involved.

Finally, the costs or tenders for future jobs cannot be anticipated as easily and correctly as with the piece-rate system, where the labour costs are nearly fixed from the start. This last disadvantage is, by the way, also connected with the system of fixed hourly rates; but in this case it should be removed by systematic time studies which, however, are rarely carried out, for it is assumed that the costs of these studies are not justified unless they are used as the basis for the remuneration of the workers. It has already been pointed out why this assumption cannot be considered as correct.

The Piece-rate System in Practice. The following are the reasons why the piece-rate system has been preferred in industry to all other systems of payment by results, although anyone with detailed knowledge of its fundamentals as well as its application in practice will agree that the piece-rate system is not by any means free of defects. It must be admitted on the other hand that these defects very often originate not in the principles involved but in their wrong application, as the following explanation may serve to show.

A piece-rate price can be built up correctly only by calculating the necessary working time and multiplying this time by the appropriate basic money rate for the unit of time, usually the hour. The procedure can be divided therefore into three parts: (1) determining the working time; (2) choosing the appropriate basic rate for the unit of time; and (3) multiplying the time and the basic rate. Point (1) has been dealt with previously in this book. Point (2) is mainly a matter of agreement between the federations of employers and the trade unions and will be dealt with later. What has to be said about point (3) has been given above under the heading "The Relation between Time and Wages," and it seems so simple that no further explanation should be necessary. Unfortunately it is not so in practice. On the contrary, it is a habit—one may even say a bad habit—to obscure the two terms "working time" and "basic rate" by adding a factor to the first instead of to the second before carrying out the multiplication. At first sight this seems harmless; for example, everybody knows what is meant when in an agreement between the federation of employers and the trade unions, the shift arrangements were adjusted as follows—[1]

(*a*) First shift shall consist of 43 hours work for which 47 hours shall be paid.

(*b*) Second shift shall consist of 37½ hours work for which 47 hours shall be paid.

(*c*) Third shift shall consist of 37½ hours work for which 47 hours shall be paid.

As a matter of fact it means that the rate of a person in the first shift is increased by $\frac{47-43}{43} \times 100 = 9{\cdot}3$ per cent, and that of a person working in the second or third shift by $\frac{47-37{\cdot}5}{37{\cdot}5} \times 100 = 25{\cdot}3$

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[1] All quotations used in this connexion are taken from the agreement between the Engineering and Allied Employers London & District Association and the trade unions.

per cent for his or her working time; 43 hours and 37½ hours respectively multiplied by these increased rates, would give the gross earnings.

Likewise: "Overtime worked whether before or after the normal working hours shall be paid in respect of the first two hours at the rate of time-and-a-third and thereafter at the rate of time-and-a-half," means that for the first two hours a rate increased by 33⅓ per cent, and thereafter a rate increased by 50 per cent should be paid. As already mentioned, that habit is harmless in these cases as no misunderstanding is possible, for there cannot be any doubt about the actual length of the working time. The matter becomes more serious as soon as the calculation of working time and for piece-work prices is in question. Assume a piece-work price has been fixed for a worker with a basic rate of 1s. per hour and for a job taking 4 minutes' working time based on time studies. Now piece-work prices shall be such as will enable a worker of average ability to earn at least 27½ per cent over his basic rate (excluding war bonus), and the correct calculation would therefore be as follows—

Basic rate per hour: 1s. + 27½ per cent = 1s. 3·3d. = 15·3d.

Working time 4 minutes: $\frac{4}{60} = \frac{1}{15}$ hour.

Price per piece: $\frac{15{\cdot}3}{15} = 1{\cdot}02$d.

Unfortunately the calculation is very often carried out as follows—

Basic rate per hour: 1s. = 12d.

Working time 4 minutes + 27½ per cent = 5·1 minutes = $\frac{5{\cdot}1}{60}$ hour $= \frac{1}{11{\cdot}75}$ hour.

Price per piece: $\frac{12}{11{\cdot}75} = 1{\cdot}02$d.

Of course, as might be expected from the first, the result is the same in both cases. It would, however, be wrong to conclude from this fact that it is a matter of complete indifference which way is chosen. Experience has shown that this is not so. The working time expected from the worker is 4 minutes and not 5·1 minutes, and he should compare the time he has actually taken with the first and not with the second figure. It has already been pointed out that this makes it easier for the self-control of the worker and has the psychological effect of making him more time-conscious. The fact that he is familiar with this kind of calculation and knows that he must use less time than 5·1 minutes, almost makes things worse; for if he thinks about the whole matter at all he must wonder why a wrong and longer time has been given to him than he is expected to use, and it must arouse his suspicions against the whole calculation. If, however, he does not ponder the matter, he may feel subconsciously that he is not being properly treated, that there must be an ulterior motive for choosing the obviously illogical method instead of the more simple and more correct one, and here he may even be right. The less reasonable way is perhaps chosen because of the desire to keep the money rate as low as possible so that its change to a lower level, in the event of a deterioration of economic conditions at some time in the future, should not be attended with too great difficulties. To avoid this possible difficulty the tendency is to put up with continuous trouble arising from the mingling of the time and money factors.

In order to be quite fair to all parties concerned, it may be added that this tendency to keep the basic rate low is sometimes even encouraged by trade union circles. The reason for this behaviour can only be to preserve a point of agitation which would, of course, not stand the test of thorough investigation. It could, nevertheless, be used in all cases where such an investigation is not expected.

Up to now it has been implied that the "pure" piece-work system has been used, i.e. that, throughout the whole shift, work is done only against piece-work prices and that these form the exclusive source of the gross earnings of the worker. This, however, is very seldom the case. Interruptions of the regular work—only too well-known to every production engineer—nearly always occur. They cannot be avoided completely, although they should be restricted as far as possible. Jobs must be inserted which for some reason or other cannot be put on a piece-work basis. Nearly always in these cases the expedient of paying the time involved at a fixed hourly rate may be chosen. This is undoubtedly correct from a theoretical point of view. There is, however, the temptation to increase artificially—by wrong bookings or other means—the time taken by these interruptions, so shortening the time taken for the actual piece-work, and thus increasing the total earnings. The interest of the workers in this procedure is obvious, but sometimes they even have the help of a foreman who is weak enough to give way to the workers in the hope of having fewer difficulties with them on other occasions. Although there is no question that this practice borders on fraud it is seldom admitted as such. Only strong measures of control can prevent harm arising from this source.

Other still more important reasons why the "pure" piece-work system is hardly ever applied in practice, are: the introduction of a minimum limit of earnings; and the introduction of the National Bonus.

With regard to the *minimum limit of earnings*, it may be called to mind that there have been at times long discussions as to whether or not this guarantee of a minimum income can be considered as fair to all concerned and not contrary to the essence of the piece-work system. Fortunately, this question is now decided in the affirmative for all practical purposes and many reasons for grumbling have disappeared. The position of the workman is such that only in rare cases would a considerable fall below the average level of earnings be tolerable; in other words, the guarantee of a minimum income is an economic necessity. As to the *upper limit of earnings*, there is likewise agreement that no other limitation should exist but that due to the ability and willingness of the worker, or at least the regulations with regard to alterations of established piece-work prices cannot be interpreted otherwise. It may be true that the bad habit of "cutting prices,"—i.e. reducing piece-work prices "because the worker earns too much,"—has not yet disappeared completely in spite of its lamentable consequences in the distrust created between management and labour and the resulting "ca' canny." A great improvement in this respect has certainly taken place, however, and the time seems not far off when this evil usage will belong completely to the past.

The situation with regard to the *National Bonus* needs a more detailed explanation. It is stated in the National Agreement of June, 1931, between the Engineering and Allied Employers' Association and the unions: "In all cases the time rate of the worker concerned shall be guaranteed irrespective of earnings, the time rate being explained as the basic rate and the National Bonus. Piece-work prices shall be such as will enable the worker of average ability to earn at least — per cent above the time rate (excluding war bonus) and the war bonus is at present — shillings."

The percentage left open in this statement has changed in the course of time. It has been for a fairly long time 25 per cent, but was altered in 1943 to 27½ per cent, the figure obtaining at present.

In order to understand the position with regard to the *war bonus*, for which again the actual figure has been omitted in the above quotation, it is useful to remember the history of this item, which has been known in the course of time under various terms, such as "war bonus," "cost-of-living bonus," "national award," etc., but will always be referred to hereafter by its present official title, i.e. National Bonus, although the other terms are still very often used in practice. This may cause come confusion in the minds of people who are unaware of the interchangeability of the terms.

National Bonus is applied in two forms—

(*a*) National Bonus for piece workers.
(*b*) National Bonus for time workers.

The time workers' National Bonus is higher than the piece workers' National Bonus, in order to offset partially the higher earnings possible to a piece worker.

As the general idea of the National Bonus was to keep wages in the engineering trade in proper relation to the cost of living and to the economic position of the engineering trade, and as it was designed to cover the payment of time and piece workers alike, the bonus was not included in the basic rate, and does not rank for what is generally known as *piece-work bonus*,[1] because its inclusion in the basic rate would have the following effect in the case of three different workers, assuming that a uniform increase of 4s. per 47 hours weeks was agreed—

	s.	*d.*
(*a*) Time workers' increase	4	0
(*b*) Piece workers' increase when earning 27½ per cent piece-work bonus	5	1·2
(*c*) Piece workers' increase when earning 50 per cent piece-work bonus	6	0

Further, an attempt to counterbalance these difficulties by introducing a system of graduated increase, based on the past piece-work bonus percentages of the workers, would make them feel that the harder they had worked in the past the lower the increase would be to which they were entitled.

When one views these difficulties, the reasons for applying uniform increases as a National Bonus, quite uninfluenced by the payment-by-results earnings, are made clear, but it is also necessary to point out the defects clearly connected with this use of two different wage systems in the same shop at the same time, which is what the introduction of a uniform National Bonus in addition to the piece-work system obviously involves.

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[1] This term must be considered as an unsuitable choice, as it is often used as simply "bonus," and the confusion with the National Bonus as well as with a part of the payment by so-called "bonus-system" may easily happen. Actually, it is no "bonus" at all, a term that is explained in the *Oxford Dictionary* as "a boon or gift over and above what is *normally* due." This 25 per cent or 27½ per cent, or whatever the percentage may be, was granted, as has just been explained, for *normal* work to a worker of *average ability* in the case of piece work. In order to understand why this percentage has been granted, one has to go back to the origin of this addition, which, being much smaller at the time of its introduction than at present, should be a reward to the piece worker, above the hourly rate of the time worker doing the same kind of work, as a counterbalance to the larger risk involved in piece work owing to the possible fluctuation of earnings. In spite of this fact the percentage mentioned here is referred to as "piece-work bonus," according to the usual language in the shops; but readers should keep continually in mind the incorrectness of this term according to the above explanation, and at least always use, as far as possible, the complete term "piece-work bonus," in order to avoid misunderstanding.

The position should be reviewed from time to time to ensure that the National Bonus payments do not become disproportionate to the basic rate payment, as it has happened in the past. The situation in 1942–43 was such that while production showed an increase of 25 per cent, income rose only 15 per cent, because the National Bonus formed such a high proportion of the total income. This was one of the reasons for trouble with the men and, after negotiations in 1944, part of the then National Bonus was added to the basic rate at which piece work is paid and it resulted in income increasing by 22 per cent for an increase in production of 27½ per cent. As may be seen, the discrepancy between increase of production and increase in earnings diminished but did not disappear; this could not be expected as there was no alteration of the method of payment, but only a numerical change in the influence which the two different systems of payment—basic rate and National Bonus—have on the total payment. It is time to say that the existence of the National Bonus as well as the piece-rate system means nothing else than using two different systems of wages at the same time, the National Bonus paid on the number of hours worked, and the piece-work rate system paid on the amount of work done, with all the difficulties which must by necessity arise from such a mixture. To keep up the original fiction that the National Bonus should be a compensation for the increase in the cost of living and has nothing to do with work, there should be only one logical consequence. The two payments should be separated from each other; for example, the piece rate should be considered as the recompense for the work actually done and therefore to be paid by the employer, while the National Bonus being the payment for the increase in the cost of living should be paid by the State, perhaps through the Post Office, as is the case with old-age pensioners. In order not to be misunderstood, it may be added that this is not put forward as a serious proposition, but only to make quite clear to the reader the difference between the two kinds of payment.

The Money Factor of Wages

The Necessity of Rating the Money Factor. The money factor in wages should be related in accordance with the difficulty met with in the performance of the job to be done and the degree of ability and training required of the worker doing the job. While the function explained by this sentence has first been termed "job rating," it is now, following the American example, usually called "job evaluation." Very often it is still completely omitted in practice and the rates given in the agreements between employers' federations and trade unions for the various trades are used without further question. These rates, as is generally known, are the result of collective bargaining and are subject to all the weaknesses and defects due to this origin. They are therefore not accurate enough for the purpose in question and are fair neither to the employer nor to the worker. This conviction has led to the development of what has been called "job evaluation" and has already become a great influence in various other countries, especially the U.S.A.; in this country, however, there are only a few companies who are known to use this technique, and few publications have drawn the attention of the public to it.

In order to explain the problem, a very simple and well-known example may be quoted: Assume three different machining operations, each occupying exactly the same time, say 30 minutes. One man can do the first with a simple centre lathe; special care is perhaps necessary for the second, for which a very small tolerance of inaccuracy is prescribed to suit the requirements of fitting it into another part, or for some other reason; the third needs intimate knowledge of a special apparatus on the lathe and care in its handling. In these circumstances it would be absurd to say either that the economic value of the three jobs was 30 + 30 + 30 = 90 minutes or that the three jobs were of equal value. Possibly the second man's work could be judged to be worth 25 per cent more and the third man's work even 50 per cent more than the first man's, so that the calculation would be $30 + (1{\cdot}25 \times 30) + (1{\cdot}50 \times 30) = 112{\cdot}5$ value units, and some such judgment is used in fixing the payment of the men. If we pay the first workman a wage of 1s. 4d. per hour, the second will have 1·25 × 1s. 4d. = 1s. 8d. per hour, and the third 1·5 × 1s. 4d. = 2s. 0d. per hour. The conclusion from this consideration is that the agreement must contain under the heading "turner" at least three different hourly rates—1s. 4d., 1s. 8d., 2s. 0d.—or if there are more intermediate steps, any hourly rates varying from 1s. 4d. to 2s. 0d., leaving it to the discretion of the rate fixer which rate he thinks suitable for the job in question. Only intimate technical knowledge of the job will be a tolerably accurate guide to the choice.

The Rating of the Money Factor. It must be admitted that to expect an agreement to cover such a demand is to ask the impossible from a theoretical point of view; for our knowledge of the nature of work, which alone can be a guide to its evaluation, is still so incomplete that no satisfactory answer can be given to the question of how a real and fair classification of the work done in our industrial workshops could be built up; but that is no reason for completely setting aside this task. What is not possible to-day may be possible in the near or remote future. The course of science has always been, first to state a problem, then to recognize its difficulties, and lastly to overcome them. It may, however, be worth while trying to go as far as present knowledge allows to show where there are limits and how far therefore the results obtained can be considered as only approximations.

It has been explained that "time" is necessary in evaluating a performance. It is, however, not the only determining factor. This does not mean that the importance of the determination of time should be considered in future as of less significance than at present, but that something else has to be taken into account besides "time." We recognize at once how different the evaluation of a period of time, say an hour, can be when we are doing different jobs, of which one is pleasant, the other unpleasant. This shows that the value of a performance is dependent not only on the time taken, but on certain qualities used by the person performing the job, such as thought, attention, etc. In other words, the worker should feel that the payment is fair not only for the *result* of the work, which is measurable by quantity, weight, time, etc., but also as computed by other factors, such as expenditure of energy, skill, quality in its performance, and responsibility, which are not measurable by one of our usual measuring systems, and yet must be taken into account in some way or other.

The rating of the money factor, i.e. the evaluation of the job, can best be approached in two stages: (1) the classification of the work, (2) the evaluation of the work

The *classification* of the work is carried out according to the difficulty of its performance. This can be done by considering the work itself, or the demands made upon the worker. Judgment should be made on the work itself, as being more objective, but where necessary, perhaps because a criterion to judge the work is missing, the human aspect should not be excluded. In this second case it is not an individual worker who has to be taken into account, as in the former case of rating an observed performance, but a worker who can be considered as representative of the group to which he belongs.

The *evaluation* of the work means to grade the various kinds of work according to their value as ascertained by measurements, which must be adapted to the individual characteristics of the work in question. Such measurements are time and quantity of output, as well as all those characteristics that the time-study engineer should observe during his investigation. All possible methods of accurate measurements have to be applied, and where these are not available, then approximations have to be made, based on comparison or experience, on common sense, or even on discussion with the foreman or a suitable worker.

When the classification and the evaluation of the work have been done as closely as the present scope of physiological and psychological science will allow, it is necessary to compare them on some numerical basis, which is usually done by one or other of the so-called "point systems." A table is drawn up in which the various kinds of work are listed in the left-hand column, the various characteristics used in the evaluation of the work in the first horizontal row of the same table; the rectangles formed by the intersection of the rows and columns are filled by numbers indicating the "points values" of the characteristics described at the top of the table for the kinds of work described at the side of the table; and the sum of the points in a horizontal row is considered as a measure of the total value of the kind of work described.

This explanation may be illustrated by one process: simple milling or planing work without accurate adjustment, measuring by calliper slide done by a semi-skilled worker, as described at the left of the table *x*th row from the top, has the following points values for the various characteristics in the rectangles of this row—

1. Work carried out according to instructions	3 points
2. Heavy work, standing, manipulating workpieces of 22 to 55 lb	3 points
3. Necessary average intelligence	2 points
4. Necessary low degree of skill and experience	1 point
5. Low accuracy and quality of the work: plain fit	1 point
6. Understanding of the necessity of order and cleanliness within the limits of a single place of work	1 point
7. Necessary independent simple thinking and responsibility required for mechanical mass production	1 point
Total	12 points

The value of a point in money is expressed in the agreement between the employers' federation and the trade unions. Suppose that the hourly rate of 1s. 6d. has been allowed for work of 6-points value and 2s. 4d. for work of 25-points value, then the value per point is $\frac{2s.\ 4d. - 1s.\ 6d.}{25-6} = \frac{10d.}{19} = \frac{1}{2}d.$ and the rate for the 12-points work is: $1s.\ 6d. + (12-6) \times \frac{1}{2} = 1s.\ 9d.$

When surveying all these considerations on how to classify and evaluate work, it can be understood that many people in practical life will doubt their usefulness for actual application and dismiss the matter as a theoretical whim, but they should hesitate before making such a hasty criticism. On the one hand it would not be the first time that an idea ridiculed in the beginning but sound in principle has given an impetus to a valuable development; on the other hand, the attempt has, in many cases, already been made—it may be admitted, sometimes more or less haphazardly—to overcome the difficulties which arise from present conditions.[1]

Of course in order to be successful in these endeavours, various requirements must be fulfilled. First, accurate results of sufficiently comprehensive method and time studies must be at hand; secondly, the confidence of the workers must have been obtained that no price-cutting of any kind will take place; thirdly, existing agreements must either give sufficient free play for introducing such a classification without endangering the economy of the works, or they must be altered to allow for it. Finally, all concerned must be aware of the fact that this is a job that needs time, patience, and good will; that only real co-operation can lead to success; that—particularly in the beginning—mistakes are natural and should be corrected by mutual agreement. Just these difficulties, however, or rather their overcoming, bear in themselves a reward in so far as they offer numerous occasions to create the right spirit in the works, contributing to the improvement of the relations between management and workers, which must be considered as so vitally necessary for continuous mutual success.

Logically, the consideration of this problem should ultimately lead to tables or graphs containing figures for evaluations which represent the results of all investigations. There should be several of these tables, each incorporating another method of measuring and judging as enumerated above, and they must be combined in the correct manner to suit the job. Their application must be adapted to some extent to the peculiar working conditions of the shops where they are to be used; and the final results cannot be transferred from one shop to the other or from one works to another without careful consideration. There is, however, undoubtedly scope for generalization of the results if they can be based on a sufficiently large field of investigation.

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[1] Bene, Eugene J.: "Job Evaluation and Merit Rating," *A Manual of Procedures*. National Foremen's Institute, New York, 1943. Charles Walter Lythe, M.E.: *Job Evaluation Methods* (The Ronald Press Company, New York, 1946).

There is much dispute about details of these point systems; whether it is sufficient to have only a few characteristics or whether it is necessary to increase them to as many as twenty-five or more; whether the maximum number of points for each characteristic should be equal or varied in accordance with the importance of the quality in question for the jobs under consideration, etc. These matters are of less importance if it is remembered that the whole method cannot be considered as scientifically accurate and is only a method of approach to a problem where real measurements cannot yet be made, because science has not yet developed far enough to give the required basic figures. It is rather an expedient for comparing with each other the importance of properties which are in principle not comparable, and where pure guessing is helped by estimating facilitated by subdividing and analysing the problem in a reasonable manner and subjecting each part to a careful scrutiny. Exaggerated extreme accuracy does not seem to be necessary. Some recent American investigations appear to indicate that, provided the characteristics required are carefully valued from experience and practice, small differences occurring in the valuations do not greatly affect the final results. For the time being, the best way to overcome all these difficulties seems to be to develop a method by discussion among experts, keeping the problem as simple as possible, and to consider it when developed as a standard for the industry concerned, until science and experience have progressed far enough to improve this standard. The great improvement would be that the money factor would be based on carefully selected figures, which indeed could not be considered as absolutely correct but would not contain the obvious contradictions which are so frequent to-day as a consequence of the present haphazard method of mutual bargaining.

CHAPTER XVII

PRODUCTION CONTROL

It is obvious that it is not sufficient simply to arrange the course of production and to let it go at that in the hope that all will proceed according to plan, without any hold-up due to human or material agencies. A conscientious works or production manager will convince himself personally that everything is being done as intended, or, if not, will find out what has caused the deviations from the original plan. If the extent of the works is such that he himself can no longer carry out this controlling activity, he transfers it to one of his subordinates, at first perhaps as a side line, but later on, when the extent of the works warrants it, as his main occupation. Finally, if the undertaking becomes large enough, a whole department with manager, assistants and auxiliaries develops.

It must not be forgotten that there are three questions which must be answered in order to control production—

1. Do the products possess in each stage of production the properties required with regard to dimensions, shape, quality, etc.?
2. Is the number of products asked for really produced?
3. Are the dates of delivery kept as promised?

Co-operation with Planning

It is clear that answers to the last two questions will tell whether or not the production plan has been fulfilled. Investigation of the reasons for the plan's failure at any point will show whether the plan has been properly made or whether the circumstances which have caused the deviations from it are of a permanent or temporary nature. Now it cannot be denied that the Production Planning Section is easily inclined to lose touch with reality. Its plans must be continuously checked against practical experience and their suitability for the situations actually arising. They must also be limited in extent to what properly belongs to production planning. Therefore it can only be recommended that the people who have to answer the above questions 2 and 3, should keep in close touch with the production planning people. Those who plan and those who control should work as a unity, under one responsible manager. Therefore the expression "Production Planning and Control" which is so common in practice should not be considered as originating by chance; on the contrary it is a guide to the development of the organization, in this case in contrast to others where an activity and its control are in principle better kept apart. The testing of the quality proper (see above, Question 1), however, is of such importance for the whole undertaking and so different from the other work done by Production Planning and Control that the establishment of a completely separate department seems inevitable. This department or section, independent of both Production Planning and Control and of Production, is usually called Inspection and will be dealt with in some detail later on. Whether the checking of quantities produced and times of production should also be transferred to Inspection—work which is usually considered part of the control of production—is a question which has to be dealt with on the merits of each case. The judgment of quality of production by inspection usually results in a number of rejects, so affecting the final quantities produced and times of production. This consideration alone should be enough to prove, that, whatever the details of organization, it is essential for Production Planning and Control and Inspection to be in the closest possible liaison.

The Delivery Programme

For the control of production with regard to quantities produced and times of production, arrangements must be made which are closely adapted to the kind and extent of the production. Generally a delivery programme will be drawn up based on the main delivery dates fixed at the beginning of the preparation work at the committee meeting of all those mainly interested in the production of the order. The main delivery dates, of course, give only the frame for the more detailed delivery programme, which may have to give dates for the reception of raw materials, the completion of each part, and the completion of each sub-assembly and assembly, so that there is an even flow from raw material to finished product. In the case of single or jobbing production the fixing of the dates for the completion of the sub-assemblies and the final assembly may be considered sufficient, for batch production the finishing dates for each part may be added, and for mass production the finishing dates of each operation on each part. This division into job, batch, and mass production should, however, be considered only as an indication to give the reader an idea how far to go in fixing a delivery programme. The decision on how much detail is required can be made in each case only after the process planning as well as the determination of the working time has been done. The usual means for letting Production Control know how production is progressing are either to give the job of finding out and reporting to one employee, usually called a "progress chaser," or to rely on written reports from the shops. Here again no general rule for the choice of method can be made, but a progress chaser is possibly preferable as written reports may lead to the usual bureaucratic difficulties and inflexibility.

ROUTING CARD Nº		ORDER Nº	
NUMBER OF PIECES	OBJECT	DRAWING Nº	MATERIAL Nº

INSPECTOR					

COURSE OF THE WORKPIECES

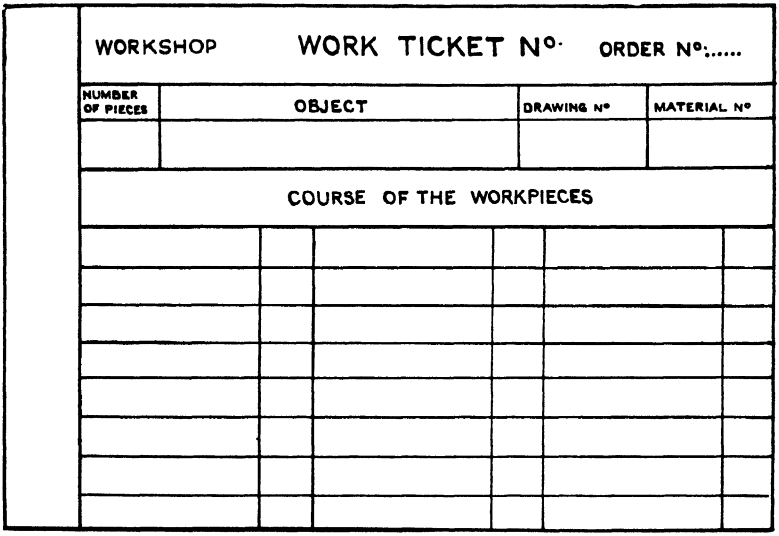
1		2		3	
4		5		6	
7		8		9	
10		11		12	
13		14		15	
16		17		18	

FIG. 8. ROUTING CARD

Quantity and Quality Control

If, however, the quantities produced are to be controlled as well as the finishing dates, these measures are not sufficient. Of course during the preparation work the shops are accurately informed of the extent of the work orders, the necessary materials are delivered from the stores, and the wage tickets give the numbers of parts and finished products which are required, but as already mentioned Inspection steps in at some stage and, as no production is perfect, rejects a certain numbers of these parts and finished products as not reaching the required standard of quality; such parts either cannot be used or require further machining or manipulating. It is clear that if quantity control is made the responsibility of Inspection, it can only be subsidiary to their main job, quality control.

Fortunately it is fairly easy to make arrangements for Inspection to report on the amount of production they have passed as being up to standard. It is only necessary to issue some form of document giving the number of parts or amount of work required and the operations or processes which have to be completed. Space is left for Inspection to note the number of parts or amount of work it has accepted or rejected. The results may again be divided into rejects due to defective material and rejects due to bad workmanship. This division is rather important, as the first gives useful information about the raw material supplies and the second about the operator or machine. If there is some piece-work or payment-by-results scheme in operation, it is usual either not to pay for rejects due to bad workmanship or to subtract the time taken in rectifying them from any bonus earned.

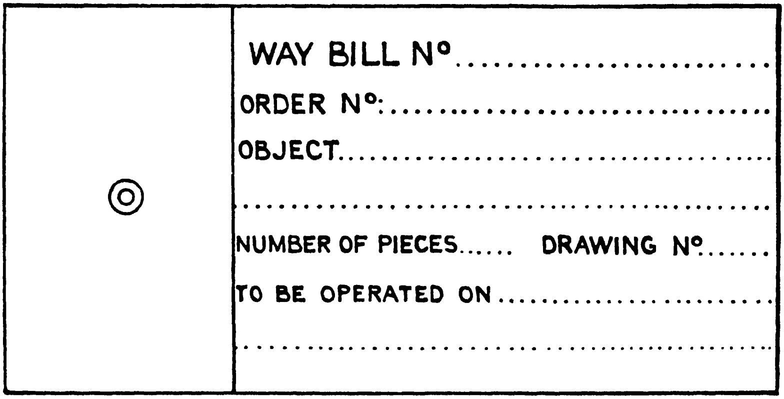

WORKSHOP WORK TICKET No. ORDER No.:.....

NUMBER OF PIECES	OBJECT	DRAWING No	MATERIAL No

COURSE OF THE WORKPIECES

FIG. 9. WORK TICKET

In the main these documents can be divided into two classes, the Routing Card (Fig. 8) which gives all the operations through which the parts have to pass and which has to follow them about from shop to shop and machine to machine, and the Work Ticket (Fig. 9) which is issued for each operation when it begins and is returned to the office on completion of inspection. The routing card, in itself simpler than the work ticket, leads to greater difficulties in practice if the quantity of workpieces on one card has to be divided at any stage amongst a number of machines or processes for reasons which could not be anticipated, and then, still divided, has to go on to the following stages. If these cases are rare, the difficulties can be overcome by withdrawing the old card and writing out separate new cards for the part-quantities; but if they happen frequently, it is better to use work tickets from the first, and experience in practice has shown that for this reason the work ticket is to be generally preferred if the production in question is not an old-established one. The routing card has the advantage that the workpieces are never without identification and it can be used as a document for taking them from one workshop to another. With the work ticket, it is necessary to introduce some simple form of Way Bill (Fig. 10) and Delivery Note (Fig. 11), to be made out by the workshops. Routing cards and work tickets must, of course, be made out by the Production Planning and Control Office.



WAY BILL N°........................

ORDER N°:..............................

OBJECT..................................

....

NUMBER OF PIECES...... DRAWING N°......

TO BE OPERATED ON........................

....

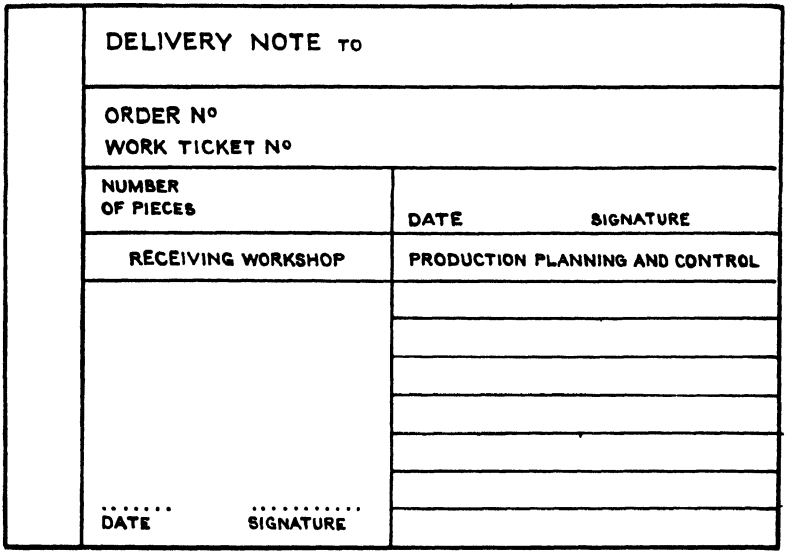
Fig. 10. Way Bill

There are many other methods which all have the same purpose and differ only in their manner of execution. The two methods described should be considered only as typical examples which have been applied in practice with good success.

All methods try to make it possible to follow the course of production through the shops and to have reliable figures which will enable the quantities produced and the time of production to be quickly and accurately known, so that control of production can operate efficiently. Mention has already been made of the various graphs and charts on which the production figures can be plotted so that they can be readily surveyed and followed.

The documents used to inform the office of the shops' production figures are various. The chief requirements are speed and accuracy.

A tear-off portion of the routing cards can be used, but this sort of thing is to be avoided as it produces small documents which are difficult to read and are easily lost. When applying the work-ticket method the delivery notes can be passed on to the office after being used for the transfer of workpieces from one workshop to the other. Routing cards and work tickets, since they are used primarly for inspection purposes and report the quantities produced, do not report the time of production. They may also be rather slow in getting to the Production Control Office as they have to pass through so many other offices. It is fairly easy to add the production time to the delivery notes. Another method is to use the worker's wage tickets. As a rule the worker on completion of his work gives his wage ticket to the workshop clerk; it then goes to the inspector for countersigning and on to the Wages Office to be prepared for payment. This simple and straightforward course can be varied to pass into the Production Control Office after inspection by the inspector; Production Control take the figures about quantity and time of production from the wage tickets before they go to the Wages Office. This method cannot be generally recommended, however. In practice it leads to delays or even to loss. The course of the wage tickets should be kept as simple as their main purpose allows.



DELIVERY NOTE TO

ORDER Nº
WORK TICKET Nº

NUMBER OF PIECES	DATE SIGNATURE
RECEIVING WORKSHOP	PRODUCTION PLANNING AND CONTROL
.... DATE SIGNATURE	

Fig. 11. Delivery Note

As important as, if not more important than, the control of delivery dates is the control of the number of parts made or the amount of work done. To maintain delivery dates it is essential to have the right numbers of parts completed when promised. No other single factor will so much delay delivery as the production of too few parts or too little work. As already mentioned, the source of the loss of workpieces during production is the rejects, which cannot be completely avoided. The replacement of these rejects is therefore of the greatest importance, especially as there is always the danger that rejects may be concealed by the workshops because of the inquiries and discussions that they may cause. The best help in this case is an intimate co-operation between the Inspection and the Production Control Office, perhaps by the inspector informing Production Control directly, on a special form called the Reject Ticket, about the rejects which cannot be repaired. Production Control has then to decide whether the rejects have to be replaced, and if so to what extent this is necessary. For instance if it is a question of some stock order it is probably unnecessary, because the keeping to an accurate number of pieces is rarely of importance for these orders, while in the case of a customer's order, for example, each missing piece is of importance. If, however, Production Planning and Control decides that the pieces lost as rejects must be produced anew, the preparation work in the office must be repeated exactly as if a completely new and independent order was to be completed.

These explanations will serve to show how difficult is the problem of organizing the control of production with regard to quantity and time, especially when it is realized what an immense number of different processes, operations, materials, and machines have to be co-ordinated and controlled in many modern industrial plants in order that the final products may be made in the most economical manner and with the least possible delay. In these circumstances it is of the utmost importance to consider carefully before any organization or reorganization is done whether and to what extent the suggested arrangements are really necessary. It is at this stage that over-zealous organizers have unfortunately done so much damage in practice, by building up organizations so top-heavy and unwieldy that they could neither follow the rapid movement of production nor give a correct statement of the production position; what is still worse, production is delayed or even stopped by the network of administration connected with these essential controls. Thus a prejudice against the sound basic ideas of the organization of these arrangements has been the result, which in some cases has gone to the other extreme of taking control of production away from the office and trusting to some kind of self-regulation growing up in the works, as it usually does in the course of time. There is no rule or test which the organizer can apply to tell him how much or how little organization is required in any particular case; he can be guided only by experience and common sense.

PART IV

EXECUTION OF WORKS ORDERS

CHAPTER XVIII

THE PURCHASING DEPARTMENT

The Purchasing Department has already been mentioned and something said of its tasks. It has to procure all raw materials used in the works as well as to buy all parts and finished products from outside suppliers. It has also to place the orders for new capital investment and for the maintenance of existing plant and buildings, if this is done by outside contractors. It should be a rigid principle in the whole works that no individual or department should place an order with any outside supplier except through the Purchasing Department. If this principle is neglected the main purposes of the Purchasing Department, the avoiding of unnecessary purchases and expenses and the obtaining of supplies on the most favourable terms, will be defeated and the stores will be overfilled with equipment, so tying up working capital.

The Purchase Requisition

The work of the Purchasing Department is based on requisitions which may come from any place in the works which needs supplies from outside. They should be so made out that they fully specify the material, machine, spare part, etc., needed, and clearly show any special requirements. These requisitions originate, in so far as they are concerned with the production proper, mainly in the Production Planning Section, but other sections of the works also occasionally need supplies from outside. As naturally the Purchasing Department cannot have the same knowledge of what is needed as the section or department which makes out the requisition, very careful descriptions with drawings, sketches, or samples should accompany it. In difficult or very technical questions the department or section concerned should be allowed to deal with the suppliers direct, to make its requirements clearly known, the final order of course always being placed through and with the approval of the Purchasing Department. In order to facilitate at least a superficial judgment on the part of the Purchasing Department of the necessity and suitableness of the orders it is sending out, and to give to the buyer the feeling that he is not doing purely administrative work by forwarding the requisitions in the form of an order to the supplier, the manager of the Purchasing Department should have the opportunity to acquaint himself with the extent of the incoming customer's orders, with intended new designs, with alterations in the production, new investments of any magnitude, etc. It is especially recommended to let him participate in conferences on these questions and to have every access to the necessary lists and statistics. In this respect the previously mentioned co-operation with the Production Planning and Control office is of special importance.

The Observation of the Market

One of the main tasks of the Purchasing Department is to keep in close touch with the market in order to cover as advantageously as possible the demand for any raw material which is needed in large quantities, and to be able to conclude contracts for it at a favourable moment. It is not necessary to discuss this question in great detail, as this has already been done from the point of view of the Sales Department; it is only necessary to remember that for the Purchasing Department "a penny saved is a penny earned." A very usual, but especially difficult decision where the purely financial outlook is frequently at a loss and where it is essential to call in technical advice, has to be taken when a choice has to be made between two materials of different price but also of different quality. Will the cheaper material of inferior quality be as efficient or, if it is used, will difficulties arise which cost more than the savings to be made by buying it, taking into account moreover that its use may, for some reason or other, damage the reputation of the firm? The manager of the Purchasing Department should not hesitate to ask the advice of his colleagues in the Design and Production Departments; nobody will expect from him such a profound knowledge of all the details involved as to be able to make such decisions independently.

The Collection of Price-lists

The Purchasing Department has to endeavour to provide all figures, papers, documents, price-lists, etc., which may be needed for making purchases, and to keep all this information in such a way that it can be easily found and consulted. The Department should have not only a complete collection of price-lists and catalogues of those firms from which it is constantly buying, but also it should collect and keep other papers and printed matter of this kind which come to hand in one way or another even if they are of no immediate importance, as future developments may make such knowledge essential. Of course, it must be admitted that there exist to-day many books of reference which contain the names and addresses of firms classified under their trades, goods they make and stock, services they perform, etc. Whilst such books of trade references are useful, indeed essential to a Purchasing Department, they cannot go into great detail or include all possible sources of supply, and much time and correspondence can be used in finding out exactly what each firm given in the reference book is really equipped to do. In fact nothing can replace the information which a really "live" Purchasing Department can provide.

It is evident that the firms which appear in the Purchasing Department's lists may also appear on the list which the Sales Department has built up of customers and prospective customers. This may in turn lead to the idea of amalgamating both collections, that of the Sales Department and that of the Purchasing Department, which would have the advantage—and it may be sometimes a great advantage—of drawing the attention of the user of such a collection to the fact that certain firms are in contact with each other both as suppliers and as customers, and that the possibility of an interchanging of business and trade exists. The proposed amalgamation of the two collections of price-lists or catalogues into one naturally raises the question of whose duty it is to look after this collection, and the answer will probably be found by looking for that department whose work is the nearest related to the administration of such a collection, which means that the first choice will be the library. There is no question that this choice is correct from a theoretical point of view, but it is not certain whether practical considerations do not outweigh its correctness and may even lead to the reconsideration of the decision to amalgamate the two collections. The basic principle, quite often unrecognized, on which all such arrangements as libraries, collections of books, papers, drawings etc., are built up is that they are to be used for giving a certain type of information which is considered of primary importance and that they are, therefore, developed in such a way that this particular type of information can be easily obtained. Of the sort of information most useful to Sales or Purchasing Departments, they are of course themselves best informed, the library perhaps not at all. Then also the locality of the library may be some distance away from the Sales or the Purchasing Departments and that always means a loss of time. It is clear there are reasons for as well as against the amalgamation of these two sources of information and it must again be left to the general management to make the final decision in each case; this again will probably depend to a large extent on the personalities of the three managers mainly concerned, the sales manager, the buyer, and the librarian.

Inquiries and Comparison of Offers

The Purchasing Department sends inquiries based on the requisitions and supported by any other information at hand to those firms who may be considered as possible suppliers for the goods or materials needed. If the requisition deals with matters where contracts and price agreements already exist, or if the order is so insignificant in value that the administrative work involved does not pay and it is possible to pass the requisition on in the form of an order to the supplier, no inquiries need be sent out, but in these cases care should be taken that the price of the goods—perhaps previously settled by word of mouth or by telephone—is confirmed in writing so that disputes are avoided.

The number of firms to which the same inquiry is sent is generally left to the judgment of the manager of the Purchasing Department. As a rule three or four carefully chosen firms are sufficient to test the market situation. As only one firm can obtain the order, to send out a large number of inquiries unnecessarily is to trouble too many people to no purpose, and serves nobody's interest.

The offers received as a result of the inquiry should be tabulated, if necessary on a printed report form prepared for this purpose, in order to make it easier to compare them. Since many factors may influence the final decision on the placing of the order a note of all relevant matters should be made in the report. Whether the manager of the Purchasing Department decides on his own responsibility where to place the order, whether he has to consult or even obtain the signature of some other department manager, such as the manager of the department which issued the requisition, or whether he has to consult and obtain a signature from the general management are matters which can be decided only on the merits of each case. Again the question of personality is of great importance, particularly as the position of manager of the Purchasing Department is one which is particularly open to abuse by corrupt practices and the acceptance of bribes. This danger can be much exaggerated, however, and care should be exercised to see that any precautions taken do not discourage the individual from taking responsibility. In the two cases which have occurred in the author's own practice, where managers of purchasing departments have not resisted the temptations of their positions, the main reason was later acknowledged to be that their salary did not stand in the right proportion to the enormous values that they had to handle professionally.

Price Conventions, etc.

The opportunity is taken here to mention the influence which a modern development in the organization of industry—the formation of price conventions, rings, syndicates, trusts, etc.—has on the activity of the Purchasing Department. There is no question that in those branches where they have gained more and more importance, the comparison of competitive offers as explained above has become almost unnecessary, in fact almost impossible, as the traders are bound more or less to the prices fixed by the association to which they belong. These considerations are sometimes pushed so far that it has been stated that the art of buying, formerly nearly the most difficult job in commerce, has become one that could be left to anybody. This attitude must be regarded as an error of judgment that can have serious consequences. There are still a lot of materials and articles the prices of which are not fixed by rings and monopolies, and a skilful buyer often finds, even for materials protected by a ring, a way to gain some advantage, in spite of all cartels and syndicates. Buying, even to-day, is not an easy art, and it is one where experience certainly plays a great role. It may be that some branches of industry are so closely price-controlled that it is almost immaterial from what firms supplies are obtained, but the position may easily change from one day to the other, and only continuous and very attentive study of the market can provide for all eventualities. It is also necessary to control all suppliers, even those with whom one has worked for years, by occasionally obtaining offers from other suppliers. Only in this way is it possible to keep a check on costs and to prevent abuses.

Orders and the Order Book

As soon as it is decided who is to receive the order, it must be written out in such a way that all necessary details are clearly stated. The general buying conditions, in so far as they are independent of or differ from any special conditions imposed by buyer or seller before the order is placed, are best fixed once and for all and embodied in a printed form enclosed with the order or printed on the back of the order itself. It is advisable in both cases to mention these general conditions expressly in the written order as only then is it certain that they will be considered legally valid. Likewise, care should be taken that the confirmations which are received from the supplier are absolutely identical with the order; if deviations are found, corrections must take place immediately and again in writing, as in disputes the settlement that was last fixed in the letters exchanged is generally considered as binding.

The offers of those firms unsuccessful in obtaining the order must be expressly declined, unless the inquiry contains a clause stating that the offer will be considered as declined unless it is accepted within a definite period. Experience has, however, shown that if the letter notifying the suppliers of their lack of success is allowed to deteriorate into an empty form and is done by means, say, of a printed postcard, it may have a bad effect; this is largely a matter of courtesy. Suppliers who receive such a card too often, without an occasional order, will become irritated and refuse to make further offers. This is also the chief reason for not sending out more inquiries than is necessary; especially is this the case where the inquirer himself is not in a position to place an order, but is only in search of information on prices to enable him to complete his offer to someone else or for some other preliminary calculation or estimate.

It is usual to keep an Order Book which is mainly used for numbering the orders in the sequence in which they are sent out, as well as a collection of the copies of the orders themselves. The numbers are used to identify the orders in all correspondence relating to them and the order book is used to enable them to be quickly found. Repeat orders, even if identical with previous orders, should always be given a new order number. This book is, moreover, a great help in obtaining the necessary statistics about the orders placed, such as their total value and the terms and conditions on which the suppliers have accepted them. It is, however, not advisable to use this book for other purposes, such as following up orders to try and ensure that they are delivered in the time promised; the bound book, which is essential to make sure the orders are properly numbered, has not stood the test for such purposes. The bound order book should contain only the absolutely necessary information in the form of subject headings; the detailed order book can be made by collecting copies of orders and filing them numerically. From this and with the help of a card index for the delivery dates it is possible to follow up each individual order, a procedure that practice has shown to be absolutely necessary. Some thought should be directed to finding the best methods for following up orders. The usual practice of sending printed postcards as reminders that the date of delivery is approaching or has passed, is frequently without any success, because in many cases such printed matter disappears too easily into the waste paper basket. It is therefore preferable, at least in important cases or after repeated reminders, to write a special letter or even to send a representative to visit the suppliers, the entire expense being more than repaid by the advantage of punctual or improved deliveries.

Card Indexes of Suppliers of Goods

In some cases it is considered necessary to keep in the Purchasing Department other card indexes giving information about the suppliers with whom the firm is working and the goods they supply. The first can easily be combined with the following up of the orders by dividing this card index into two parts: delivered and undelivered orders. The second would be better developed independently from the first on specially printed cards giving the names of firms under the headings of the goods they supply. It should also contain the names of firms known to be sources of supply but with whom no business connexion has yet been established, so serving as the list of sources of supply already mentioned. It should, however, not be forgotten that in these matters it is easy to go too far. Before the establishment of these card indexes is decided upon, an investigation should be made into the amount of work, which is generally larger than expected, entailed in starting and maintaining them and whether they are likely to repay this trouble and expense. Experience has shown that it is in the Purchasing Department that there is a danger of over-estimating the advantage of these "mechanical aids," which are generally really useful only if very large contracts are being dealt with, and even then are profitable only if they are kept very carefully.

The Purchasing Department as Inspector of the Supplier's Invoices

It is clear that nobody in the whole works is so well informed about the conditions on which materials, substances, goods, machine parts, etc., are ordered, as the Purchasing Department. Under these circumstances it seems obvious that the first and most important examination of the invoices of the suppliers should be done in this department. This proceeding is, however, open to a considerable objection which in many firms has led to this job being taken away from the Purchasing Department. It is wrong in principle to make anybody responsible for the verification of work done by himself. Nobody would dream of giving to a cashier the job of verifying his cash—it is done by someone else completely independent. So the idea of leaving the buyer to check the supplier's invoices is rightly regarded with some hesitation and a special control is arranged for it. This arrangement has, however, the disadvantage that at this control position the whole correspondence which has passed between Purchasing Department and supplier, and which may be considerable, has to be worked through. The author's experience seems to indicate that the first idea should be followed in spite of the doubts which may be directed against it, and supplier's invoices should be checked by the Purchasing Department, who should then forward them to the cashier with a covering-note of acceptance explaining, if necessary, the conditions of payment. As, however, some measure of protection against the possibilities of fraud and mistakes must be arranged for, it is usual to obtain a second copy of every invoice either by copying the invoices received or by asking the suppliers to provide the other copy. This latter method is, as will be explained later, wrong in principle but is so common in practice that it hardly ever causes any difficulties. This second copy is sent to the cashier's office or to some other suitable department and payment to the supplier takes place only after receipt of the invoice has been acknowledged by the controlling department as well as by the manager of the Purchasing Department. The person responsible in the controlling department may not be obliged to check all details of every invoice as the manager of the Purchasing Department is, but only to check thoroughly sample invoices taken at random. The invoices so checked should not be known to any other person. Moreover the department which receives the goods has to confirm that what has been ordered has really arrived and is correct as to quantity and quality.

These methods as a whole give considerable security against fraudulent practices in the Purchasing Department, but they are not completely excluded, and when very large sums are involved it is reasonable to insist that invoices are not sent to the Purchasing Department at all, but are examined, verified, and passed for payment by another completely independent department or person.

CHAPTER XIX

THE RECEIVING AND STORAGE OF MATERIAL

THE substances, materials, goods, parts of machines or equipment, etc., which come to the works from outside by railway, water, lorries, messenger, or in any other way, are delivered to the Receiving Depot, or, if this is not possible owing to the weight or bulkiness of the commodities, they have to be entered into the books of this department, which has to be informed of their arrival and is responsible for any further transportation about the works which may be necessary. Generally the Receiving Depot has to count, weigh, or otherwise measure the quantity of goods as soon as they arrive on the firm's premises and check their quantity and description with the advice and delivery notes.

The system of advice and delivery notes is almost universal to-day. The advice note is sent by post by the supplier to advise the customer that he has dispatched the goods, and usually arrives days, weeks, or even months before the goods. The Receiving Depot should check the advice note, as soon as it is received, with the copy of the order sent by the Purchasing Department to the Receiving Depot when the order is placed. Any discrepancy between order and advice note must be notified at once, without waiting for the receipt of the actual goods, either to the Purchasing Department, or, better still, direct to the supplier with a copy to the Purchasing Department. This check of the advice note is most important as much trouble, expense, and time can be saved if errors in dispatch have been made. The delivery note, which should be attached to the goods, if necessary in a special weather-and-oil-proof envelope, is usually a carbon copy in all essential particulars of the advice note and should be checked against the advice note and any discrepancies notified, usually to the Purchasing Department, leaving them to take up the matter in this case direct with the suppliers.

Checking the Goods

Some preliminary checking of the dimensions and the quality of the goods takes place as far as the Receiving Depot is able to do it. The more accurate check of quality, which is not always necessary, *but has only to be done for some materials and goods, is the job of* another department, the Technical Inspection, and it is quite often done by the same department which inspects the firm's own output. This department, therefore, has to be informed of the arrival of the materials, goods, etc., and has to decide whether such an accurate test is necessary and whether the delivered commodity is according to specification and can be accepted and used for the purposes of the works. The actual work of this Technical Inspection Department will be dealt with later on, but it is important to point out here that a close liaison between Technical Inspection and Receiving Depot is essential; unfortunately in practice it is in many cases lacking, because of the frequent disputes on points of competence and responsibility. Here again the organizer must be extremely careful; it is necessary to delimit very clearly the exact work and responsibility of these two departments, which are subordinated to two different executives in fairly high positions. A close examination of all details may be unavoidable, but it must not be forgotten that at this stage quick decisions and rapid action are very often necessary as production may be waiting for the material that has arrived; whilst delays, which should be reduced to a minimum, may occur because of the tests which must be carried out. Delays due to lack of co-operation or to actual jealousy between departments cannot be tolerated for any reason whatsoever.

From the Receiving Depot the commodities required have to be sent on to their proper store or to the place where they are to be used, but their further issue can be allowed only if the technical inspector has agreed that they are correct as to quality and the Purchasing Department has agreed that their order has been properly fulfilled and that the supplier's invoice for the commodities is in order. Finally all departments which are interested in the arrival of these goods must be informed. How this should be done will be explained later, after some important questions about storage have been answered.

The Purpose of Storage

Material management problems can best be understood if the purposes of storage are clear. They should be so to everybody from his experience in daily life; but when these simple ideas are applied to industrial matters, so many mistakes may be found in practice that it seems worth while to consider these problems in a little more detail. It is the more important as in modern times it has been suggested, owing to the success of certain American manufacturing methods, that stores between the Receiving Depot and the production are an obsolete method and should be eliminated as quickly as possible. This is an exaggeration of an excellent idea, which has led as often as not to converting the great advantages of the new method into as many and perhaps greater disadvantages. The manufacturing method in question may perhaps best be termed "continuous-flow production," sometimes, mainly in non-technical articles, referred to as "work on a continually moving conveyor belt," which means employing one individual kind of tool or expedient used in this kind of work for its characterization. It cannot be denied that it is *possible* in especially favourable cases to do without storage, i.e. if success has really been reached and it is possible to work without gaps or breaks and to maintain this flow continuously. The question of how far the method of continuous-flow production can be introduced into our industry, in which works of small and medium size still form the overwhelming majority, should not lead to its being forgotten that in most cases, even if this new method can be and is applied, stores in the old sense of the word are still essential. Of course, it must be admitted that this method of work permits the extent of the stores to be limited—and that alone is an advantage which should not be underestimated—but nevertheless no responsible production engineer would venture to do his job even with the best continuous-flow equipment without any stores at all. His work would get into such a state of uncertainty that complete collapse would be almost inevitable as a result of the small troubles and hold-ups unavoidable in practice. Therefore it is right to state that under present working conditions production cannot be considered as a practical proposition without a carefully developed store system. This will not be altered by the fact that the idea of continuous-flow production certainly has and will have a great influence on the methods of production in our factories. In order to avoid misunderstanding, however, it may be expressly added that this development, which has already begun in some industries, can be confidently expected to continue and expand; for the fundamental ideas of the method of continuous-flow production are sound and if they can be carried through, without mistaking the externals for the method, our industrial works will have made a considerable progress.

The reason for a system of storage between the Receiving Depot and the production is that it is in most cases only by the use of such a system that it is possible to—

(1) buy material in bulk, i.e. at reduced price for reissuing in small amounts and to ensure at the same time that the stock level remains within economic limits;

(2) make certain that material is always available when needed, even if long deliveries are demanded by the supplier;

(3) review thoroughly the economic situation in the works and establish effective production control.

These three points—quantities, time, and costs—hardlv need further explanation at first glance, but the problems are so intricate that the greatest care by the management is necessary in order to avoid mistakes which may be detrimental to the whole concern. The problems are similar to those which arise in connexion with the stock order when it is a question of deciding what quantities are to be made and who is to be responsible for this decision. Here they arise in a more acute form and require even more careful handling. The whole problem is of such vital importance that a repetition of some of the considerations that apply to both cases seems to be advisable in order to give a complete picture.

The difficulty is that the theoretical approach to these problems has proved to be almost impossible. That at least is the author's experience, although many attempts to give mathematical formulae and other rules can be found in literature. What must be taken into account is that the storage of excessive quantities is connected with all the losses that follow over-investment, and at the other extreme that stores in too small quantities involve the danger of shortage just at the time when the material is perhaps most urgently needed for production. In steering between these two extremes there is, properly speaking, nothing more than common sense to guide. Some help can be obtained from former experiences in the same works, and from past statistics, but even these may be misleading if the working conditions, especially the degree of activity in the works, are different. Thus the only general rule that can be given is that the quantities in store should have a certain margin of safety because the disadvantages of "too much" are smaller than those of "too little." In addition, the nearer the approach to continuous-flow production throughout the works the smaller can and should be the storage of material.

The Subdivision of Material to be Stored

Distinction should be made between—

(1) *Direct material*, i.e. raw material transformed into goods in the works by any of the manufacturing processes and contained finally, at least to the greatest part, in these goods.

(2) *Indirect material*, i.e. material used and consumed during production.

(3) *Finished material* or *saleable goods.* These distinctions cannot be applied to a particular material in general; on the contrary, they can be used only from the point of view of the works in question—i.e. what belongs in one case to one of these groups may in another case be part of another group. For costing purposes, however, it is necessary to make this distinction clear once and for all in the particular works; and where, as sometimes happens, a change takes place from one group to another, to provide for special measures of transferring so that correct book-keeping takes place. For example, round bars may be saleable goods for the works in question, and so be stored in the warehouse, but such bars may also be needed for some repairs and have to be transferred to the "indirect material" account in sufficient quantities to cover them.

Special attention must be given to material that arises or is left over from the production process and is known as *scrap.* Scrap has to be collected immediately after it has appeared and brought to the scrap dump where it belongs, and it should be credited to the order or workshop where it arises.

The Arrangement of the Stores

Here, too, it will be possible to give only some general principles, as all details have to be adapted to the special nature of the material to be stored.

The question whether an *open stockyard* accessible to everybody, or a *closed stores* or *warehouse,* should be chosen will be decided according to bulkiness, weight, and value of the material. It is clear that the latter form is the better one from an administrative point of view, as it is easier to keep check on what is at hand when only a limited number of persons responsible for the material have access to it. The former arrangement is therefore permissible only when the danger that unauthorized people may displace or remove material without a voucher is excluded by the nature of the material, as is the case with ore, scrap, ingots in iron and steel works, etc. It may be expressly mentioned that these remarks are based less on the fear of loss by theft—in many cases this loss would be less than the cost of the supervision of the stores—than on the fact that "open" stores make the necessary survey and book-keeping almost impossible.

Stores Administration and Control

A much-discussed question is whether the actual administration of the *stores* and the *control* of the stores by suitable book-keeping should be in one person's hand or kept strictly separated. Any ill-feeling on the part of the storekeeper, who may look at such a separation as a sign of distrust, must be disregarded; everyone in industry has to consent to being controlled. It is clear, that, in principle, only separation can be right, because nobody's work should be controlled by himself, as has been pointed out on various occasions. Experience has shown, however, that there are cases in practice where it may be advisable to break with this principle, and separating the administration and control of the stores may prove to be one of these exceptions. The combination of proper storekeeping and book-keeping sometimes brings about a far more intimate knowledge of the requirements of the works concerned than either of these two activities by itself ever will produce. This knowledge can be a real asset, especially in stores of great size with perhaps thousands of various parts where "drugs on the market" only too easily arise, which a careful and experienced storekeeper could avoid. This is again one of the occasions where it is evident that the persons available in the works cannot always be fitted into its existing organization; so the organization must be altered and built up to suit the persons available. It may be decided, for instance, to combine administration and control under one storekeeper and to reverse this decision when he retires and an adequate substitute is not available.

If separation of control and administration is decided upon, one mistake—unfortunately found frequently in practice—should always be avoided. In spite of the book-keeping being done by the control a sort of book-keeping is arranged in the store itself, which is sometimes considered as an intensification of control without being so in practice. The result in this case is an increase of clerical work, not only by duplication but also because the two books or cards dealing with the same object must be made to coincide if a discrepancy arises. Thus it can often be observed that in addition to the book-keeping of the stores—at present nearly exclusively carried out by card indexes—the bin cards in the stores are continued, which contain nothing more than some of the items on the cards in the main book-keeping, in both cases based on exactly the same vouchers. A useful economy has been obtained by suddenly scrapping these bin cards after the separate main book-keeping had been put in good order. One cannot object that the storekeeper then has insufficient survey of the contents of his store; he has only to look into the bins. But he is deprived of the possibility of artificially making the actual stock coincide with that on the bin card; thus real control by the main store book-keeping is established.

Another point of administration may be mentioned, the neglect of which often leads to trouble and sometimes even to booking the same material twice. Any purchased material should be charged to the stores and issued from the stores. It should not be immediately charged to a special order, even if it is actually brought to the spot where it is to be used because of its bulkiness or because it can be used for no other purpose.

The Stock in the Stores

It has been mentioned that the greatest attention must be given to the quantity of the stock in the stores, i.e. the difference between the amount of material received and the amount issued, which is the amount of material remaining in the stores. Attention must be drawn here to one other detail: This stock is not always really available for any new order, because it is possible that it is already partly requisitioned by previous orders not yet sent to the shops. Distinction should therefore be made between the "real" stock at hand in stores and the "available" stock which is free for new orders. Simple as this idea is theoretically, it is sometimes difficult to carry out in practice. In any case, careful organization and an especially close connexion between the Order Book, the Production Planning Department, and the stores book-keeping must be made, but over-organization avoided. This distinction between real and available stock should be made, therefore, only where it is really necessary to avoid delays in delivery, etc.

The Organization of the Stores

It is impossible to define clearly the position of the stores in the organization of the works. All that can be said on this problem should only be taken as an example of how this question may be answered in particular cases and what advantages and disadvantages are connected with the solutions adopted. Thus it is often discussed whether stores belong to the technical or commercial side of the undertaking and whether they should therefore be subordinated to the works manager or to the commercial manager. The author has found that the answer depends in practice mainly on the characteristics of the persons concerned—another instance where the personality of the people at hand determines the kind of organization, and not vice versa.

Economic reasons, however, nearly always seem to demand that the management of the stores should be independent of that of production proper. To a certain extent the stores control production so far as the economical use of raw material, the delivery of finished goods, etc., are concerned. Close co-operation between the stores manager and the individual managers of the production departments would therefore be the correct reflexion of their relations to each other. The stores are bound to work with production, as the supplier with the customer; and it is well known that the best negotiations are conducted on equal terms.

Requisitions and Returns to the Stores

An indispensable rule, which is so often referred to as "red tape," and which must appear at first glance to the inexperienced mind really to be so, must be observed in all stores.

Nothing should be taken out of the stores without a regular requisition slip. How often does one hear complaints about the unnecessary paperwork for a few pence, about all this work "only invented by clerks in order to provide work for themselves and to show their own importance." But it must be emphasized that unless this rule is strictly enforced no real survey of the economic situation of the works, no orderly book-keeping and correct profit and loss account, is possible. The author knows that exaggerations occur here, but it is the "rule of large figures" which should be kept in mind, the fact being that the sum of numerous small items is finally a large item and that these small items easily add up in a big works to many thousands a week. There is no alternative to the use of requisition slips for each item. In cases where the stores must deliver, for technical reasons, more than is asked for, the return of this excess with a return slip is equally important. Naturally, the whole procedure should be made as easy for the workshops as possible by suitably printed forms, by correct situation of and clear arrangement in the stores, etc., but that is the most that can be done. The fundamental procedure, as already explained, cannot be abandoned.

The next stage in treating these requisition slips is the valuing of the material, for which they are the vouchers. There are in use various methods of doing this and the most usual are: (*a*) to take the *actual value of the material*, as shown by the invoice in cases where the material is delivered from outside, or by calculation when produced or transformed in the works; (*b*) to choose the *market price*; (*c*) to fix a *standard value* unchangeable for a certain time, perhaps the business year; or (*d*) to use the *refund price*. The author prefers personally the method under (*a*), especially since it can be reasonably explained to the employees concerned as following most closely the actual course of events, but it cannot be denied that the other methods have advantages, which may lead to their application, e.g. in the case of great fluctuations in market prices. It is possible to find, in the same works, two or three of these methods being used simultaneously for various types of material, and it has to be agreed that in certain cases some advantages could be obtained only in this way. Of course it means a more careful training and supervision of the employees concerned. Whatever methods are adopted, it should never be forgotten that carefully as they may be thought out the right result can be obtained only if the original vouchers, the *requisition* and *return slips*, are correctly written out in the first place and the forms properly used at later stages; it is here that many queer mistakes often occur. The employees who have to do this work cannot, for economic reasons, be highly trained, and they easily become accustomed to doing their work mechanically. It is the duty of the storekeeper to supervise them continuously and to eliminate such mistakes as using wrong lines or columns, confusing the various figures, writing words or figures incorrectly, etc. These minor matters often cause trouble in an organization the main features of which may be absolutely sound. The planning of an organization is comparatively easy: it is its application in connexion with all the detail work that matters in practice and decides whether the organization is a real success or not.

In order to obtain a better understanding of stores and their organization it will be of interest to discuss in detail how the stores are connected with other departments of the works. For this purpose it will be convenient to follow an example of the flow of a material into and out of a stores and to follow the clerical work which must be done in order that a complete report on this flow may be available.[1]

Material Received in the Stores

When the material enters the works the office of the Receiving Depot makes out seven copies of the receipt, using suitable printed forms, as illustrated in Figs. 12A, B, and C. They are so arranged that the particulars on all copies are produced on a typewriter at the same time as the original is made. As may be seen, copies 1 and 2, and copies 3 and 4, are all called "preliminary receipt," copies 5, 6, and 7, "definite receipt." The differences between printed forms will be explained subsequently by their use in the various departments. The course of the copies is shown by Fig. 13.

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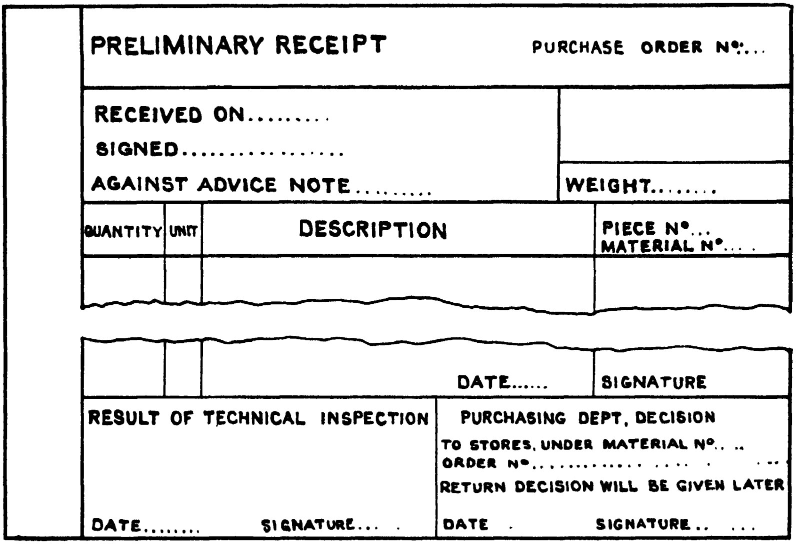
[1] The reader is asked to keep always in mind that the following description is only an *example* of how this job *can* be done, not an instruction how it *must* be done.



PRELIMINARY RECEIPT

PURCHASE ORDER Nº:...

RECEIVED ON.........

SIGNED..................

AGAINST ADVICE NOTE.........

WEIGHT........

QUANTITY	UNIT	DESCRIPTION	PIECE Nº... MATERIAL Nº....
		DATE......	SIGNATURE

RESULT OF TECHNICAL INSPECTION

DATE........ SIGNATURE... .

PURCHASING DEPT. DECISION

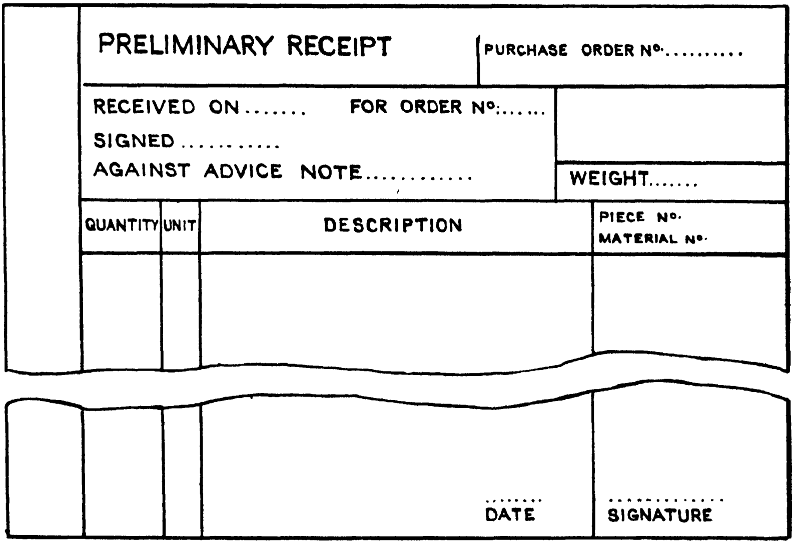
TO STORES, UNDER MATERIAL Nº.. ..

ORDER Nº............. ....

RETURN DECISION WILL BE GIVEN LATER

DATE . SIGNATURE.. ...

FIG. 12A. RECEIPT OF MATERIAL



PRELIMINARY RECEIPT

PURCHASE ORDER Nº..........

RECEIVED ON....... FOR ORDER Nº:......

SIGNED...........

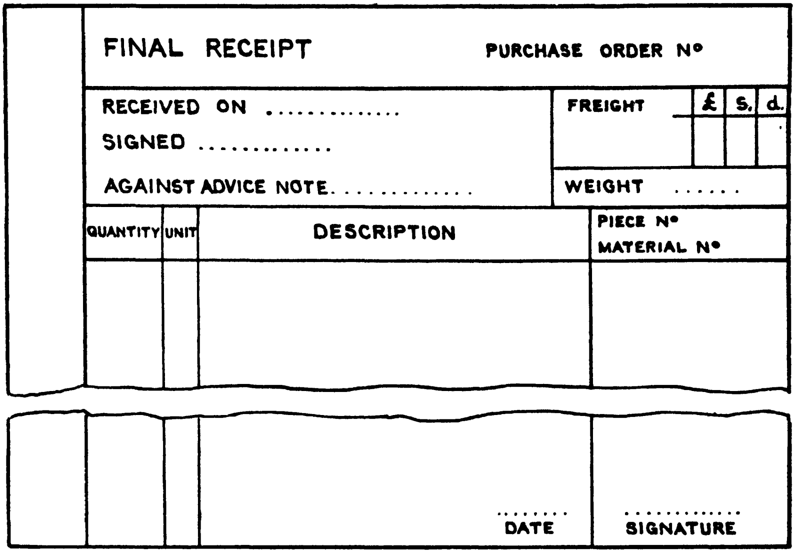
AGAINST ADVICE NOTE............

WEIGHT.......

QUANTITY	UNIT	DESCRIPTION	PIECE Nº. MATERIAL Nº.
		.... DATE	.... SIGNATURE

FIG. 12B. RECEIPT OF MATERIAL

Copy 1 (Fig. 12A) is sent to the Purchasing Department for quick information, in order to prevent unnecessary correspondence with the supplier. This copy is then sent together with the *supplier's invoice* to the Book-keeping Department—i.e. the department where the books of accountancy proper are kept—which retains the invoice and returns copy to the Purchasing Department for filing. Copy 2 (Fig. 12A) is sent to Stores Control for the quick information of the Ordering Department. Copies 3 and 4 (Fig. 12B) are sent to the Technical Inspection Department, which retains copy 3 for its files and sends copy 4 to the Purchasing Department, after having made the necessary tests and entered the results on this copy. The Purchasing Department decides whether the material can be accepted, makes this decision on copy 4, and returns it to the Receiving Depot. Here copies 4 and 5 are fastened together and sent to the Purchasing Department for comparison with the invoice of the supplier. Copies 1, 4 and 5 and the invoice are then sent to the Book-keeping Department, which returns the receipts 1, 4, and 5 to the files of the Purchasing Department. Copy 6 is sent with a copy of the invoice to Stores Control, copy 7 to the stores themselves.



FINAL RECEIPT PURCHASE ORDER Nº

RECEIVED ON ....
SIGNED ....
AGAINST ADVICE NOTE.............

FREIGHT	£	s.	d.

WEIGHT ......

QUANTITY	UNIT	DESCRIPTION	PIECE Nº MATERIAL Nº
		.... DATE	.... SIGNATURE

FIG. 12C. RECEIPT OF MATERIAL

It must be admitted that this organization seems rather complicated at first glance; and the author is the last to recommend it for every possible instance, but the reader can be assured that it has proved effective in various and very different industrial works, that it entails comparatively little clerical work, and that it gives good protection against carelessness and fraud. Special attention may be drawn to the fact that the Receiving Depot must write down the receipt according to the actual material, as no advice note or supplier's invoice is at hand when the material arrives; thus it is impossible

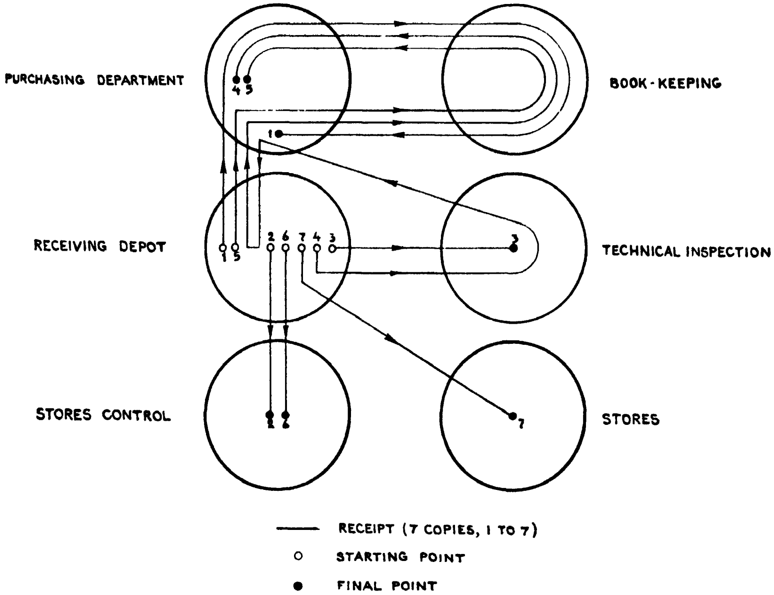


Fig. 13. Course of the Forms Reflecting the Receipt of Material in the Stores

to "copy" the supplier's invoice and to regard it as a receipt, as lazy receivers of the material are sometimes inclined to do. Another point of view worth mentioning is that no further co-operation from the supplier is expected, for instance the sending of the invoice in duplicate. It has already been mentioned that experience has shown that any organization that seeks the special co-operation of an outside firm is to some extent unreliable.

Finally it may be added that *returns* from outside of any kind are treated in the same way as new material; in these instances the intermediate storage in the Receiving Depot is very important, and if possible this practice should be adhered to so that close inspection of the returned goods is possible before they are accepted by the stores.

Material Issued from the Stores

As already explained in requisitioning material from the stores stock material may be of two kinds. Part of the stock can and should be reserved for orders already received, on which work has not begun; thus the material in stores may comprise "actual" stock and "available" stock and may require to be separated in the stores book-keeping, though in some cases such a separation may be superfluous or even absurd. The reserved stock will always be "direct" material, the available stock either "direct" or "indirect" material. Both kinds of material are demanded from the stores

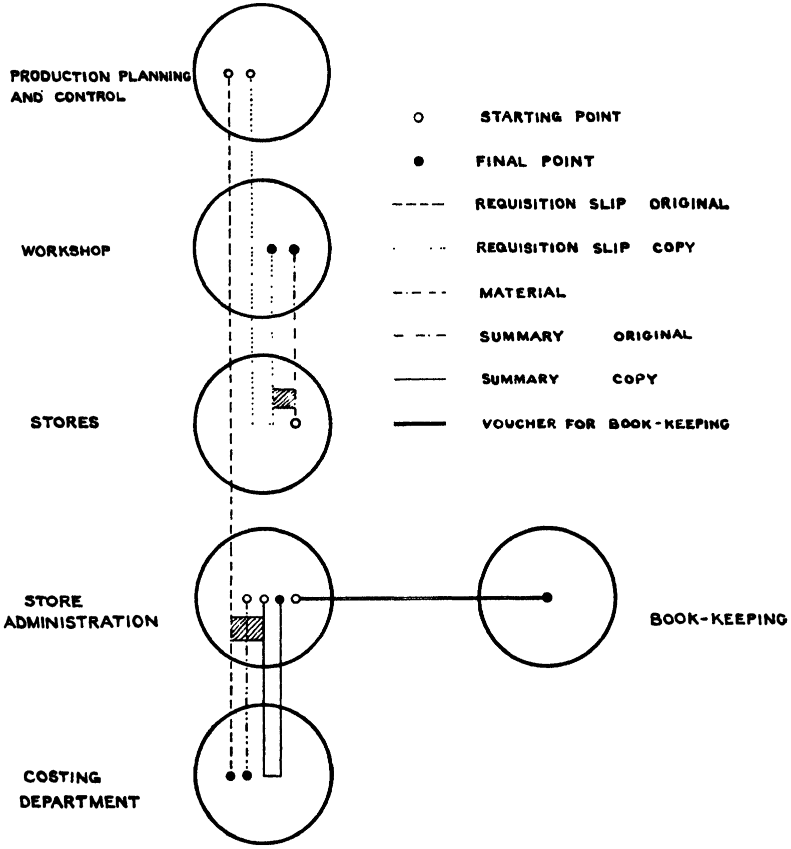


FIG. 14A. COURSE OF RESERVED MATERIAL ISSUED FROM THE STORES

by requisition slips of the same printed form, but of different colour. Requisition slips for direct material are generally made out by the Planning Department, those for indirect material by the Consuming Department; an original and one copy are provided,

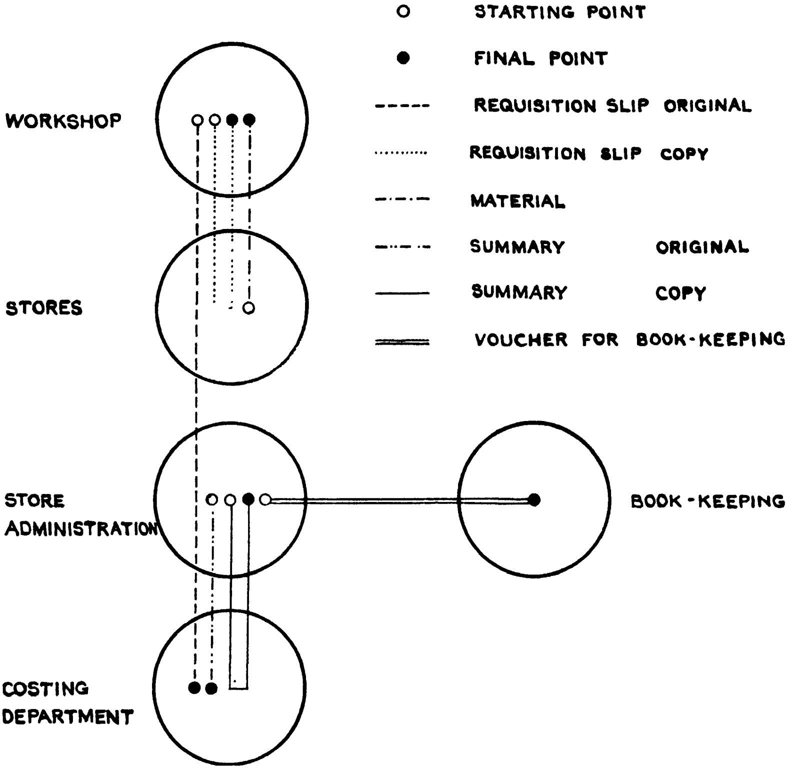


Fig. 14b. Course of Unreserved Material Issued from the Stores

having the same current number, so that all slips can be traced and controlled.

The course of the material issued from the stores, and the clerical work connected with it, are illustrated by Figs. 14a and 14b for "unreserved" and for "reserved" material respectively, i.e. where it is decided to distinguish between "actual" and "available" stocks of materials.

The Planning Department makes out the requisition slips and sends the original and the copy together to the workshop, which in turn forwards both to the stores. From the stores the copy of the requisition slip travels, together with the material in question, to the workshop, while the original is sent to Stores Control. In the Stores Control all necessary details are entered into a card-indexing system, which can be regarded as the key to the information about each material issued from the stores and must therefore be very carefully kept. This point will be discussed later. After the valuation of the issued material and the entry of the value on the requisition slip as well as in the card index, a summary is prepared and made out in duplicate. This may consist of a daily or a weekly summary, according to the number of items issued, and the originals of the requisition slips with both copies of the summary then travel to the Costing Department, where they are examined, mistakes corrected, and failures rectified. The current numbers of the requisition slips provide a guide for the latter purpose.

When the copy of the summary is acknowledged as correct, it is returned as a receipt to the Stores Control and a short voucher informs the Book-keeping Department of the necessary figures to be taken from the summary. Thus the Book-keeping Department receives daily or weekly figures for entering into the accounts, instead of figures for each detail, but the auditors can easily trace back the origin and composition of these figures to the single requisition slips, where they consider this to be necessary.

The Card Index of the Stores

A few remarks may be added about the work of the Stores Control, or rather its main tool—the stores card index. How it works may be gathered from Fig. 15, which shows only the heads of the cards and scarcely needs a detailed explanation. It gives as an example the printed form of a card, which may be used for "reserved" material and would satisfy all demands which can be put to such a document. One card is used for each type and each dimension of the material concerned, and the sum of all cards make a continuous inventory of the whole material existing in the stores if—and this is essential—the cards are used and filled in properly. That is the important and difficult duty of all concerned with Stores Control, and the superintendent and his assistants must look after the correct working of this apparatus incessantly; for as already mentioned, mistakes easily creep into these details, and, though small in themselves, may add up to amounts which may seriously affect the accuracy of those accounts which the management needs to direct the undertaking efficiently.

The foregoing explanations may be sufficient to convey a right *impression of the position occupied by the stores in the organization* of the works. It will be appreciated that the explanations are not by any means exhaustive; what is hoped, however, is that these examples show the spirit in which these matters should be approached and dealt with.

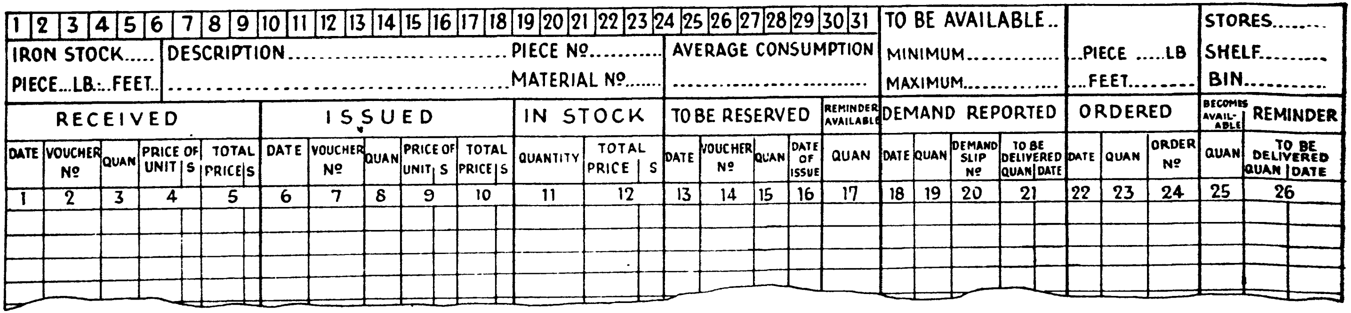
Layout of the Stores

To discuss the stores as part of the layout of the works in a general way presents many difficulties. It is proposed, therefore, to confine the discussion to the problem of the centralization or the decentralization of the stores.

It is obvious that from an administrative point of view the centralization of the stores has great advantages, and therefore there is a tendency to favour centralization. It must, however, be considered that, especially where large areas are concerned, centralized stores easily increase the transport costs beyond what may be permissible. It is often difficult to find out when this point is actually reached, because the determination of the actual losses by excess of transport is not an easy task and generally includes an estimation of some costs in addition to those that can be calculated. When looking for a suitable compromise, it should always be remembered that whilst administration is an essential service its demands must be secondary to those of the main work, especially if administration tends to increase an item with such high costs as transport generally involves.

When the transport costs from a central store are likely to be excessive, two or more stores for the same material may be located in various parts of the works, and a new and difficult task of stores control arises. It is necessary to assign the right proportion of material to each individual store, to equalize stock when issues from one store have been excessive, to consider all stores together when ordering new material, etc. The usual method of maintaining balance between the various stores is to use an individual card for each store and a main or summary card for all stores together; this certainly involves additional clerical work, and difficult clerical work too, but only in rare cases can it be avoided with advantage.

In any case it is important to guard against measures of distribution which allocate an amount of material estimated to be a weekly or monthly consumption under the control of the foremen, i.e. building up "foremen's stores," which are restocked as the material is issued to the workers. Although, at first glance, this idea



1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31

TO BE AVAILABLE..

STORES........

IRON STOCK.....

PIECE...LB...FEET..

DESCRIPTION............................PIECE Nº...........

....................................MATERIAL Nº.......

AVERAGE CONSUMPTION

....

MINIMUM..............

MAXIMUM..............

..PIECE .....LB

...FEET........

SHELF.........

BIN............

RECEIVED					ISSUED					IN STOCK		TO BE RESERVED				REMINDER AVAILABLE	DEMAND REPORTED				ORDERED			BECOMES AVAILABLE	REMINDER
DATE	VOUCHER Nº	QUAN	PRICE OF UNIT | S	TOTAL PRICE | S	DATE	VOUCHER Nº	QUAN	PRICE OF UNIT | S	TOTAL PRICE | S	QUANTITY	TOTAL PRICE | S	DATE	VOUCHER Nº	QUAN	DATE OF ISSUE	QUAN	DATE	QUAN	DEMAND SLIP Nº	TO BE DELIVERED QUAN | DATE	DATE	QUAN	ORDER Nº	QUAN	TO BE DELIVERED QUAN | DATE
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

FIG. 15. THE CARD INDEX OF THE STORES

seems promising, it cannot be too strongly emphasized that in practice the method is bad. The control of these numerous small stores becomes so difficult that often it is entirely omitted and the necessary survey is lost. The author could give from his experience convincing examples where material of a value amounting to hundreds and even thousands of pounds had disappeared from the books, and was found only after many months—material which was badly needed in other parts of the works.

Whoever believes that such or similar conditions are impossible in his own works may be congratulated wholeheartedly, but the author, as a result of his experience of industrial practice, is usually somewhat sceptical of the accuracy of such statements.

CHAPTER XX

THE MATERIAL FACTOR IN PRODUCTION

TURNING to the actual production in a factory it seems as well to mention first the problems which arise in nearly every case when the building in which production is to take place comes to be considered. The task in either building up a new factory or making considerable changes in an old one is beyond the capacity of a single human being; so varied are the subjects in which expert knowledge is needed. Nearly all functions of engineering and building are concerned and so often are so intimately connected with each other that properly to understand and consider the various points requires the knowledge of one who is a specialist in all these functions. It is obviously impossible for any one man to be a first-class architect, as well as a civil, mechanical, and electrical engineer, so that he can deal expertly with the problems of building, road and rail making, production equipment and machines, heating, ventilation, water supplies, and electric power. At the same time, of course, he must be an economist capable of choosing exactly the right site for supplies of raw materials and cheap labour, and reasonably close to the consumers of the goods to be made. He must also be a lawyer of no mean ability, since legal points are often decisive when the siting or expansion of an industry is in question, and so on.

It will be obvious to the reader that it would be in vain to try to tackle some of these problems by mathematical methods, such as have been proposed in some quarters, because practical circumstances are never so simple that they can be dealt with in this way. For instance, the author does not recollect ever trying to find the best site for a factory, which must be situated in a position such that it has the least possible transport charges to and from three points, by means of a differential equation of the various costs of transport per unit of distance. Such equations may be found in literature and have presumably been designed solely for the purpose of making good examination questions. But no one who has to solve a real problem of siting a factory ever takes them seriously, quite apart from the fact that these problems hardly ever turn up in a form that can be given convenient mathematical expression. The selection of a new site for a factory from a number of possibilities can be done only for each case as it occurs, the various advantages and disadvantages of each site being carefully considered and balanced against each other. There will be many different aspects which should be taken into account and the costs of transport will certainly play an important, sometimes even a decisive, role, but a wrong impression would be given if such a detail were to be dealt with here in the "quasi scientific" way indicated, because it is in the nature of the matter that all the aspects to be considered cannot be included in a mathematical formula. It has never to be lost sight of that although a factory or other industrial plant is naturally composed of innumerable such details, that plant only will finally be considered as a good solution of the problem from a technical and economic point of view where these details are finally combined into a harmonious whole, into a single organism devoted to the purpose for which it was created, that of getting as a member of the total economy of the country its product on the market in the required quality and quantity, with the smallest possible costs and in the shortest possible time.

It follows even more forcibly from these considerations that no one single detail should be allowed to stand out as especially important when considering the actual size, shape, and layout of the buildings, and their situation to each other; the purpose of a factory, as defined on p. xii, is in the end decisive and not the form of the building. It is of course desirable, it is probably even essential to the ultimate purpose of the whole, that the buildings and their surroundings should be aesthetically pleasing—for it is true that man gives of his best only in aesthetically satisfactory surroundings—but purpose must never be sacrificed to form. The best solution is found only where architect and engineer have worked together as real partners, with the same goal in view, and have managed to weld form and purpose into a single unity. The reader should keep in mind these introductory remarks during the following brief and by no means exhaustive survey of considerations usually affecting the layout, buildings and equipment of a factory, and of the extent to which problems of industrial administration and management are of importance in this respect. A systematic discussion of all the questions arising when projecting industrial works of any kind has never been considered as coming within the scope of the present book; still less is it intended to go into technical details, important as they may be in individual cases. It is hoped, however, that the examples given will be sufficient to define the point of view from which their selection as well as their treatment has been made.

Sites

The main considerations in the selection of a factory site may be divided into material conditions, labour conditions, and the requirements of the factory equipment. The material conditions can be further subdivided into location of the site in regard to sources of supply of main and auxiliary raw materials, location of the site in regard to markets for the finished products, the actual physical condition of the site itself, its geology, transport facilities to and from the factory, etc. It is obvious that the factory should be sited to reduce transport costs; whether closest to the source of raw materials or to the customers depends upon the relative bulks and weights of raw materials to the finished product. It should not be forgotten that proximity to the customers does enable the factory to keep in close touch with them. The geology and physical condition of the site are of importance not only because of the possible contents of the soil, which may be used as material for the industry in question, but also because the advantages or disadvantages of a bad or sloping surface may facilitate or render more difficult the making of foundations for buildings or machines, communications between the buildings of the works, etc. Where dams or other civil engineering works are necessary, complete geological surveys of the site should be obtained, but it is always essential to know about such facts as the weight-carrying capacity of the soil and sub-soil, degree of subsoil water, high-water level in neighbouring rivers, estuaries or sea, reliable supply of clean water of right quality, etc. Climatic conditions may also be of importance. While usually level ground is preferred, hill sides or sloping ground can be used to facilitate the internal transport of the material by the use of gravity, or, as in the case of iron and steel works, the blast furnace may be built at the bottom of a narrow valley in a plain, the charge-material from the surrounding plain being fed into the top of the furnace. The price of land may be of considerable influence; it will be higher in or near towns than in the country, lower in the suburbs than in the centre of a city. The possibility of later extensions should not be overlooked when purchase of land is necessary, and any rates and taxes likely to be imposed on it or connected with its acquisition must be taken into account. As already mentioned, special attention should always be given to matters of transport and communication by land—roads or railways—as well as by water—canals, rivers, or sea.

With regard to labour conditions the main considerations in choosing a site are: (*a*) supply of labour; (*b*) proximity of the works to others in the same industry; (*c*) situation of the factory in relation to workers' housing districts; (*d*) advantages of urban districts over country. It is clear that these four points are more or less connected with each other and it is not intended to discuss them separately, particularly as they are to a large extent obvious. Whether they are of more or less importance depends largely on the kind of workers needed, the amount of mechanization in the works, the proportion of skilled to semi-skilled or unskilled workers, what percentage of the labour force should be female, etc. The advantages of town over country have unquestionably been diminished by the modern developments of the radio and the cinema, which have brought some kinds of entertainment, especially valued by the workers, into the smaller urban and rural areas, and by cheap motoring and bus services, which have facilitated travelling between town and country.

The equipment of a factory affects the choice of site by raising considerations of power and water supplies, protection against the danger of fire, and sanitary arrangements. The problem of supply of power may be of decisive importance for the selection of the factory site, as this choice may depend on whether a special power plant has to be set up or whether power can be bought from a public supply authority, a question which may again require a special investigation and negotiation and careful calculation. If new generating plant is to be installed, then the type of plant has to be decided, for where steam of high or low pressure is used for production purposes it may easily be possible that an old-fashioned engine with its exhaust steam at atmospheric pressure will be more economical than a quite modern plant with condensers and a high vacuum.

Water is needed in large quantities for such undertakings as paper factories, sugar refineries, etc., or for cooling purposes as in blast furnaces. Lesser quantities will be required for sanitary purposes and fire protection. Water is supplied from a public main, from a natural source such as a river or lake, by pumping from a well, or or by a combination of these methods. Processing may be required for water to be used for drinking or for boilers, or for waste water before it leaves the factory to avoid the risk of river pollution and the poisoning of fisheries, etc. The problem of waste water removal may in some cases, such as dye or chemical works, etc., be of decisive importance in choosing the site. Whether reliance should be placed on a nearby fire brigade or whether the factory should have its own fire organization has also to be studied. In the second case the costs of the necessary frequent exercises to ensure permanent readiness, including the maintenance of all equipment, have to be taken into consideration.

The Effect of the Working Diagram on the Site Plan

The basis for a smooth and unobstructed plan of work through the factory is the "working diagram," which is a schematic representation of this plan showing the course of all main and auxiliary raw materials through the main processes, the working methods, and the machinery in the factory. The more complicated and the less easily balanced is the manufacture the more can the use of the working diagram be recommended. It is obvious that the working diagram must be drawn up to suit the particular kind of production concerned, but it has also to conform to the peculiarities of the site, such as its shape, whether level or sloping, and the points at which transport to and from outside are available, etc., and it is of no great help to develop general principles since one or other feature of an actual case will probably make it impossible to copy them. The following explanation of "return flow" and "uni-directional flow" through constructional workshops should therefore not be considered as a fundamental discussion of the aspects governing the formation of site plans of industrial works generally, but rather as examples of how in a particular industry two different types of plans have grown up and what are their advantages and disadvantages.

The principles of return and uni-directional flow of work may best be made clear by Figs. 16A and 16B. In the case of return flow the shops are so arranged that the course of the material through the factory is a nearly closed circuit, the points of entry of the raw material into the factory and the point where the finished product is dispatched from it being at nearly the same place. With uni-directional flow the raw materials are brought into the works on one side and the finished products leave the works on the opposite side. It is clear that the uni-directional flow of material is the most trouble-free, but the separation of supply and removal increases the costs of transport facilities and probably requires more space. If the return flow is chosen construction of only one road or rail bed is necessary, but as the machine shops, etc., are placed at the opposite ends of the assembly bays and the stores to the incoming and outgoing road or railway, it renders their future enlargement more difficult. These form also the transverse connexions between the stores and the bays. The transport ways are as much as possible shortened by this arrangement. The distribution of the material to the individual machine tools and then to the assembly bays is not disturbed by movements in the opposite direction. Everything to be moved can be picked up by travelling cranes.

In the case of a uni-directional plan the machine shops, placed between stores and assembly, are also the transverse connexion, but the material for the machine shops now comes in at one side and leaves the shops at the opposite side in the same direction. Unlike the return flow principle, uni-directional flow requires *two* tracks. Working conditions are usually against the use of uni-directional flow on a large scale, as the original capital investment is proportionally high. Moreover the operating expenses are also increased since the wagons unloaded in the stores must be shunted from one end of the works to the other, in order to be loaded with finished products. The arrangement of stores and shops in line one after the other can therefore mainly be recommended in construction workshops that are closely connected with rolling mills and can work directly out of their stores. Therefore it will be possible only in certain circumstances to use uni-directional flow in an economical

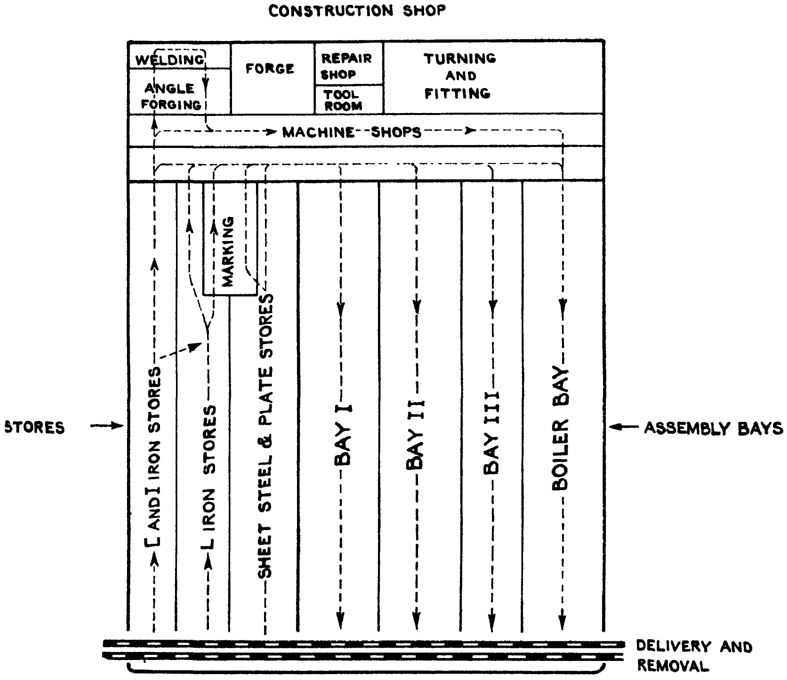


Fig. 16a. Principle of Return Flow

form throughout the whole works, but it could be applied to parts of a plant, and to individual workshops.

The Flow of Work

It has already been explained that the guidance and regulation of the flow of raw and auxiliary materials from one operation to the other is an important task of management, and in fact management efficiency can almost be measured by the speed of the flow of work, which in turn depends to a large extent on the correct planning of the factory layout. Certain things such as walls, pillars, doors, pipes, cables, machines, etc., in each plant have fixed places which cannot be changed later on, or at least can be changed only with difficulty. They should be so placed that the materials necessary for manufacture have a course through the factory as short, quick, and therefore as cheap as possible. This refers not only to the siting of various buildings in relation to each other but also to the ground plans of the rooms in the buildings themselves. For instance, it is worth considering whether in order to utilize fully a plot of land of some irregular shape a building should not depart from a plain rectangle. In buildings with several stories, stairs, lifts, pipes, and cables should be placed in wells on the outside of or between buildings, so that there are no projecting corners in the actual rooms used for manufacture or storage that might impede the flow of work. This principle can be recognized more readily when the production is concerned with a uniform product, as for instance in a flour mill or a cement works, but it is useful also in, say, a factory making machine tools with a variable production programme where the development of buildings giving the least hindrance to the flow of

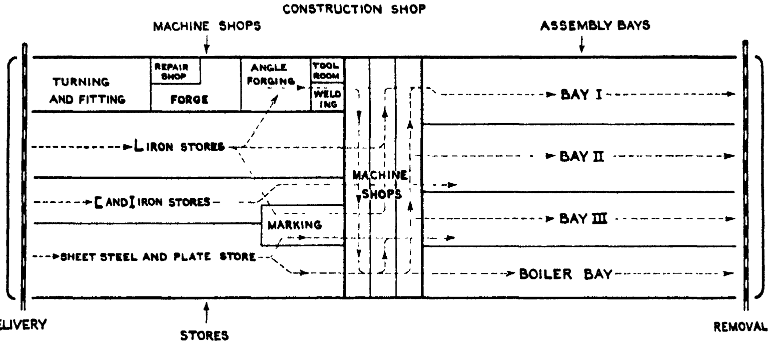


FIG. 16B. PRINCIPLE OF UNI-DIRECTIONAL FLOW

work greatly facilitates their adaptation to changes in production. The economic result will be the better the more the work approaches an automatic flow, as in giant chemical factories or in large power plants.

The idea of the continuous flow of work is of such very great and increasing importance in the modern development of industrial plants and has such a close connexion with the factory layout that it is almost impossible to consider one without the other. The return obtained on capital invested in an undertaking depends not only on the profit as a percentage of the turnover, but also on the relation between the turnover and the capital invested. One of the secrets of the success of one of the largest distributing organizations in the world is that its policy of buying cheaply enables it to have a turnover many times its capital, and so a very small profit on each sales item is multiplied many times.

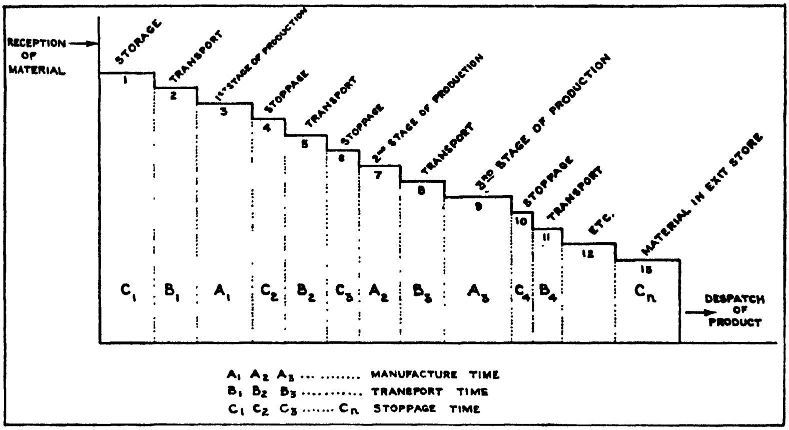


FIG. 17. MANUFACTURING AND TRANSPORT TIME

The maintenance of a continuous flow of work affects both the turnover and the capital. By shortening the manufacturing time cycle—that is to say, by reducing the time the article takes to pass through all the stages of manufacture—the output of the factory, i.e. the turnover, is increased, just as a greater quantity of liquid will pass through a pipe if there is a steady flow than if there is an irregular or choked flow. On the other hand, if the work passes continuously, smoothly, and regularly from process to process until completed, the amount of work in progress and so the material in the factory at any one time is very much reduced, thereby reducing the capital requirements of the business or undertaking. A larger turnover is thus obtained with a smaller capital investment.

This is not the only benefit obtained by efforts to produce a continuous flow. As illustrated by Fig. 17, shift time can be divided into manufacturing time and transport time or active and idle time, and whilst it may not be possible to eliminate idle times altogether it must be remembered that they have to be paid for. Whilst material is resting between processes the capital it represents is idle and giving no return; moreover, rents, rates, heat, light, etc., all have to be found for the space it occupies. Again, if the material is heavy or bulky the mere putting down and picking up again is an expensive, because unremunerative, process.

All these are very real losses and furnish a strong incentive to "keep it moving." How can this be done? The first step is to make the stream of production uniform in volume at each process, that is to say, to arrange that the plant is capable of producing at the same rate from beginning to end. Another way of stating this is to say that the production time at each operation must be the same, or perhaps slightly shorter at the later processes or operations than at the earlier ones. The information necessary for the achievement of this purpose can be obtained by means of method and time studies, and when this has been done thoroughly the stoppage times are eliminated and there is no material or work in progress resting between processes, or at any rate the amount of it is reduced so much as to be easily controllable.

There remains the transport time, which involves not only the means of transport but also the disposition of the machines and work places—in other words the shop layout. Transport and shop layout must be considered together and each workshop or factory treated as a separate problem; to attempt to give a general rule might mislead. For example, it will usually be the better arrangement from a transport point of view to place the machines in the order of the purpose they serve, which will give a quite different arrangement from that obtained by putting all the machines of a particular kind together; in some cases, however, this latter arrangement is essential. There will be later an opportunity to return to this problem.

The foregoing remarks are principally intended to emphasize the importance of endeavouring to shorten the manufacturing time cycle as much as possible and not as a light-hearted description of how to do it. It is realized that it is not an easy process, and it may take a long time to reach finality, if, indeed, finality ever can be reached. In some cases the equalizing of process times or operation times, or balancing the plant, may be relatively simple, and only involve adding a man or two or a machine or two here, or shaving something off there; on the other hand, it may be exceedingly difficult and involve the most intricate and detailed studies of the methods and machines available.

An eye must always be kept on the cost of this balancing process, and it must never be carried past the point at which it yields a good return. Like so many other things it is a means to an end and not an end in itself, and a sense of proportion must be exercised; this applies to the selection of the means of transport as well as to the steps taken to secure balanced production. The most elaborate, effective, or even most efficient means of transport are not always necessary; indeed there are many occasions, when the very simplest passing from hand to hand, or man-handling, is the most economical means, simply because it is the best suited to the case in point. Elaborate means of transport must be used to capacity to justify the capital invested in them.

The Type of Factory Buildings

Another question may be raised here, although it can be decided only on the merits of each case: Should the whole factory be placed in a single building or should each shop have its own separate building? Often this question is connected with the problem of using factory buildings of several stories or with only one ground-floor. The first form has the advantages of less internal transport, lower building costs (only one set of external walls, short pipelines, etc.), low running costs (heating, lighting, repair, etc.), easy inspection, simple control; but the single-story building avoids the interference of one department with another by noise, dust, humidity, etc.; in the case of fire the outbreak can be more easily reached, and the risk is confined to one place only, etc.

The solution in practice is usually a compromise. For instance, in an engineering factory the power plant, forge, and foundry would be in separate buildings, while the machine shops would as far as possible be kept together. The administration office, drawing office, etc., are usually also separated in order to render the work in them quicker and less disturbed, but exaggeration in this case has to be avoided, as the close connexion between the offices and the shops may be very helpful. Supplementary and auxiliary shops and services should not be neglected. They are used nearly every day by each worker, and their situation in relation to the main shops may therefore be economically of greater importance than appears at first sight. How much time can be saved if sanitary arrangements, intermediary stores, tool rooms, drawing stores, etc., are placed in the right situations. The times are gone when dressing-and wash-rooms were built in any dark corner left over from plant and machines. It is known to-day that nothing, even if only indirectly connected with production, is so unimportant that it should not be planned and carried out carefully.

The Transport Problem

The close connexion between the transport problem and the factory has been mentioned already several times. Transport facilities to and from the factory have an influence on the selection of the site of the undertaking. Internal transport is important when developing the site plan of the factory in the area finally selected and may be decisive in the question whether to build multi-storied or single-storied buildings; it may even determine the arrangement of machines and equipment within a shop. It is possible to say without exaggeration that nothing in that part of the undertaking which deals with the production proper can be altered and moved without influencing in some way the cost of internal transport. This fact has been found out only comparatively recently and it is the reason why in old works internal transport, not having received enough consideration, is nearly always a difficult problem. There is no question that very often considerable economies can be made in such cases with comparatively small investment of new capital, and it pays generally in any works to investigate the whole transport system thoroughly. It is in the nature of things, however, that a greater success is generally obtained if it is possible to plan the internal transport from the first in a new works.

The problems of internal transport are too extensive to be more than indicated in a book of this sort. In the main they fall into three categories depending on the type of materials handled. The first comprises very heavy or bulky materials, such as steel bars and plates, structural steelwork, large castings, molten metal, etc., which are almost universally handled by means of jib or overhead travelling cranes. If they have to be sent any distance some kind of rail truck is used. The second category is that of bulky material, such as coal, coke, sand, grain, heavy chemicals, etc., which are usually handled on troughed belt conveyers, scraper conveyers, and bucket elevators, or by some kind of pneumatic system. This type of material is handled as much as possible on conveyers, even over very long distances, some belt conveyers in the U.S.A. being several thousands of feet in one length. The third category is the most difficult to define and sets the most difficult problems. It is usually *called "packet" handling, because it deals with single articles,* or with a number of articles, gathered together in boxes, sacks, or other containers or "packets." The maximum size of each packet is usually but not necessarily what can be conveniently handled by one man, say a maximum of 100 to 200 lb., but is often very much smaller.

Many and various are the trucks and trucking systems, conveyers and elevators which have been devised to handle "packets." It is probably best to accumulate as many catalogues as possible from truck and conveyer manufacturers and to get their advice at an early stage in any internal transport scheme. In general terms the only guide that can be given is that the greater the number of separate packets to be handled, the more seriously a system of conveyers should be considered. If, however, the packets are large and have to be stored in racks, bins or stacks covering a large area, then some system of trucking or manhandling is indicated, at least in the stores themselves, even if the packets are brought to the stores on conveyers.

There are cases, usually falling into the second or more rarely into the third of the above categories, where the internal transport problem is of such importance to the production apparatus that the whole works must be built to give the most efficient and economic internal transport. For instance in large flour and corn mills and in modern power stations and gas works the space required for the means of internal transport, and for the material to be transported, may be larger than that taken by the actual production machinery, and it may dictate the floor heights of the buildings, as the conveyers, pipes, and power lines may be hung from the ceiling, or run in trenches cut in the floors. Moreover, in constructing the ceilings, floors, pillars, supports, etc., the additional load of the material in transport and of the means of transport has to be taken into account, and if the buildings exist already they will have to be most carefully examined and checked to see whether the construction is strong enough for the additional load.

At this point a few remarks may be added about railway tracks and branch lines or private sidings. It is no longer necessary to point out the importance of a direct connexion to the main railway. A railway siding and track usually have to be built sooner or later and the question is often given too little attention when the site plan is being developed. Cuttings and embankments may have to be allowed for to obtain suitable gradients, and it must be decided whether to make the tracks strong enough to take main-line locomotives or whether lighter internal combustion or steam locomotives only will be used inside the works and loading gauges arranged accordingly. A copy of the regulations and the advice of the main-line railway authority should be obtained at an early stage in mapping out the internal railway system. Shunting by hand should be avoided as far as possible, as it is nearly always dangerous to the operators; and turntables, whilst they save space, are wasteful of time and expensive to maintain. The provision of an adequate internal railway system will often influence the spacings of the factory buildings and in fact the whole production layout. Such a system may indeed work to a timetable almost as strictly as any main-line railway, trucks being delivered to and taken away from the various shops at stated hours during the day or days during the week.

On a smaller scale the same problems are raised by the use of self-driven electric or motor trucks, either inside a single building or between several buildings. The fact that trucks can normally move anywhere over a reasonably level surface is no reason why they should do so. Truckways should be marked out with white lines on the floor and the trucks should use them to a time schedule. They should also be carefully maintained, for potholes and small obstructions in truckways probably account for more damage to trucks and to goods carried than any other single cause. The question of internal transport which has been so briefly treated here is one of the greatest importance. Kipling wrote that "transport is civilization"; it is equally true that transport is production.

Something which in practice is only too often forgotten or not sufficiently realized is the allowance to be made for possible future expansion. It must be admitted that such allowances may result in annoying expenses, since the ground bought for expansion may lie unused for years. The whole question is very difficult, for if the land is bought and used for some other purpose to reduce the loss on unused capital the final effect may be just as bad as if it had never been bought at all, for when the land is wanted to enlarge the factory it is found to be occupied by tenants who may, because of leases or changes in the law, be very difficult to dislodge. Again it is a matter of weighing up each case as it arises, remembering always that site restrictions will affect the flow of work in general and in detail through every office and shop.

The Equipment of a Factory

This may be divided into immovable and movable. The first is generally built in when the building is constructed, and consists of pipes, ducts, wiring, etc., for lighting, heating, ventilating, water and power supply, etc., and is mentioned here only for the sake of completeness. The movable equipment can be classified more or less into machine tools and other similar machinery, tools, and devices such as jigs, instruments and gauges. They are objects of very different dimensions and it is sometimes difficult to distinguish correctly between them, for even an expert cannot say correctly once and for all where a "machine" stops and a "tool" starts, which device should be called a "tool," which an "instrument" and which a "gauge."

Frequent attempts have been made to bring a certain amount of standardization into this confusion, by laying down exact definitions of what may be understood under the various terms. As far as the author is aware these attempts have never had a favourable result either in English or in any other language, and the same objects which by one firm are carefully classified under various headings are by others lumped together in one category. This state of affairs may be deplorable, since it renders almost useless many figures which could otherwise be used to compare the economic structure of different firms, but anyone who has ever had to classify jigs, tools and machines knows how difficult it is to make satisfactory definitions of them in all cases

The best method of arranging the various items of equipment on the plan of the site is to draw out the floor area required by each item on thin cardboard to the same scale as the site plan, and to cut out these areas—which must include not only the space required by the equipment itself but also the space required to operate and maintain it and the space taken by any material on which the equipment has to work, e.g. the space occupied by the bars of metal being fed into a capstan or turret lathe. By shifting these cardboard patterns on the site plan the equipment can be rapidly grouped and regrouped until the best arrangement of it is found. It is obvious that as far as possible the equipment should be so arranged that no single breakdown should ever have the effect of stopping the whole factory from working. To avoid this possibility the following points must be taken into consideration. Alternative sources of supply must be available for all important works services such as electricity, water, gas, etc.; reliability must be considered as one of the main considerations when choosing the driving plant. "Ring" mains for electricity, water, gas, etc., should be provided wherever possible. Intermediate stores sometimes called "buffer" stores for semi-finished goods should be provided between processes and for finished goods before assembly.

Hand in hand with the agreement of the equipment must go the determination of the total space required. The space required by the equipment itself is of course known, but for other items, e.g. the intermediate stores, the space needed must be calculated or estimated, and it is better on the whole to estimate a little too high, as this is not so troublesome as if too little space is allowed and a new assembly or a change in production has to be crammed into a limited space. All the resulting figures can naturally only be approximations, but it would be a mistake to conclude, as is sometimes done, that it is not necessary to make any calculations or estimates, hoping everything will come out all right in the end. There are undoubtedly some very experienced production engineers who are able to determine the space needed for production fairly accurately without going into all details in the manner indicated, but they are rare exceptions; on the whole it is better to use every possible precaution on this important job. What is recommended is to make some additions—after having found the space needed for the main items—to cover the amount of space that has been found from experience to be necessary for those additional and auxiliary activities during production that are difficult to take directly into consideration. Here again, however, caution and common sense must be used; these additions must not be allowed to become extravagant and thus increase not only the original costs of the building but also the transport costs. To determine the space required needs imagination and the knowledge of how production can best be organized and what increase in production is probable in the future. Again it will be best, after sufficient preparation, to lay the plan of production before a meeting of those executives who will be responsible for its operation and to let them all give their opinion about it, so that they cannot say later on that they were not consulted and were not given an opportunity to make any criticisms until too late.

The majority of the previous considerations were based on the assumption that new production should be arranged on a new area, which would be more or less suited to this purpose. The task is already difficult enough, as these short and rather incomplete remarks will show even to the inexperienced; but the difficulties increase greatly, if, as is usual in practice, the production has to be put into or rather crammed into an already existing site. Another complication is that the site may already be in use producing something else which does not fully occupy the existing plant and the new production has to utilize the remaining capacity and, if possible, to increase it. It would be futile to try and explain in detail how to deal with such a case, because no general explanations can be given. Each case needs a different solution and experience and common sense are mostly the best and only guides, although some of the foregoing considerations may be useful.

Workshops

The production proper of an industrial works is divided into workshops, which can be considered as the basic units of organization and are places where certain processes are carried out differing from those in other workshops. They may be divided into main, supplementary, and auxiliary workshops according to the connexion that their resulting products have to the finished goods the works are intended to produce.

It is from the main workshops that the chief finished or saleable goods of the works originate. Supplementary workshops manufacture finished goods, usually called by-products, introduced to use up waste materials from the main production and often added long after the main workshops have begun production. Auxiliary workshops produce no saleable goods but only render services to the main and supplementary workshops. As main and supplementary workshops are naturally organized to suit the kind and nature of their products and of the technical processes used, and as these are very different for each industry, it is impossible to give any general rules for the processes used and how they should be organized that will suit every industry. The example which follows, taken from mechanical engineering, is not exhaustive and cannot be so as there are such a great number of processes which are continually changing as new materials and new methods of production are introduced. It can, however, be said that the following gives a good idea of the present state of affairs in mechanical engineering.

I. Manufacturing Processes.

1. Producing the form without removing chips; the material may be fluid, powdery, doughy or solid—

   (*a*) Foundry work, pattern work, metal casting, plastic moulding.
   (*b*) Powder metallurgy.
   (*c*) Hot and cold forming, forging, rolling, drawing, etc.

2. Producing the form by removing chips—

   Sawing, turning, planing, broaching, drilling, boring, milling, grinding, polishing, lapping, honing, superfinish.

3. Producing without form alteration—
   Heat treatment of metals.
4. Covering and protection of surfaces.

II. Assembly Processes.

1. Fusion assembly—
   Welding, hard-and soft-soldering, brazing.
2. Fusionless assembly—
   Riveting, connecting by bolts and nuts, screwing together, and other similar connexions which can be undone without destroying main members.

III. Measuring and testing processes of quality, quantity, dimensions, and efficiency.

IV. Packing.

Generally speaking each of the main workshops does only one of the above processes and this has the great advantage that the foreman as leader of the workshop can specialize in the technology of the work done in his shop. It should be noted, however, that during the past few decades a tendency has grown up to arrange the shops by products rather than by processes in order to reduce the costs of internal transport. Instead of each shop specializing in doing one process on all the products of the works that need that process, each shop deals with only one or a limited number of products and is equipped to put these products through every process and complete them.

Careful consideration and calculation have to be given to each case to find out which system has the greater advantage. To give a general decision is again impossible.

Supplementary shops dealing with by-products are of no importance in some industries, e.g. in mechanical engineering where they are rare exceptions; in others they have developed into very important parts of the industries concerned, as for instance in iron and steel works where slag-grinding mills, gas-cleaning plants, and cement- and slag-brick factories, may largely contribute to the economic success of the concern. Sometimes this may go so far that it becomes doubtful which should be considered as the main and which as the supplementary activity. A plant producing gas and coke may be termed a gas works if the gas production was the reason for its erection, and a coke-oven plant if it was originally intended to produce coke.

The Maintenance Department

Auxiliary workshops offer a better opportunity for general consideration and it may therefore be commendable to give some examples of their organization. Although the importance of an up-to-date and highly efficient Maintenance Department cannot be denied, there is no question that in many otherwise well-organized concerns it is given little attention. This is the more astonishing as the expenditure is by no means negligible. In order to give a figure which will illustrate what is meant by this remark it may be mentioned that "maintenance" in an iron and steel works of medium size with an investment of two million pounds in buildings, roads, machinery, equipment, pipe lines, cables, etc., may perhaps need a yearly expenditure of £150,000 and more.

It may be as well to define a little more clearly what is understood by the comprehensive expression "maintenance," for instance in an iron and steel works. One answer is given diagrammatically by Fig. 18 taken from the *Cost and Production Handbook*[1] which is here reproduced unchanged in spite of the fact that the denotations do not always coincide with those usual in English metallurgical works. The answer to the question how to improve the working efficiency in this department is comparatively simple in principle, though often it is not easy to accomplish in practice.

The Maintenance Department should work according to clear orders either given by one of the other workshops, because some trouble or breakdown has occurred to a plant, apparatus, or machine, or originating from a system of continuous supervision which shows where such a case of emergency would probably soon arise in the course of production. It is a test of the efficiency of the continuous system of supervision that the former kind of orders disappears more and more and with them the surprising breakdowns and unpleasant stoppages which so often upset the planning of production and increase the difficulties of works and departmental managers. This system of supervision must be built up on regular inspections, repeated at intervals which must be carefully adapted to suit the parts being inspected. These intervals should be fixed not only by manufacturers' recommendations but also from experience obtained in the works where the parts are in use, because the actual state of the plants plays an important role. It is therefore clear that the chief maintenance engineer should have a decisive influence on the development of the system of supervision.

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[1] Edited by L. P. Alford, and published by the Ronald Press, New York, 1934, p. 757.

In this connexion a problem may be mentioned which is sometimes considered excessively important in administrative circles: how to limit the expenditure on repairs to the plants? It is there pointed out that this could best be done by limiting the power of the chief maintenance engineer to carrying out major repairs without a special permit from his superior, the general manager or managing director. The author does not agree with this method. The chief maintenance engineer, one of the important persons in the works, must be a man not only of sufficient experience but also of judgment, who can be trusted not to allow any extravagance. This method of limiting his liberty of decision is dangerous, as it leads only too easily to the omission of desirable repairs or to the well-known method of concealing a major repair by dividing it into a series of minor ones in cases where the maintenance engineer

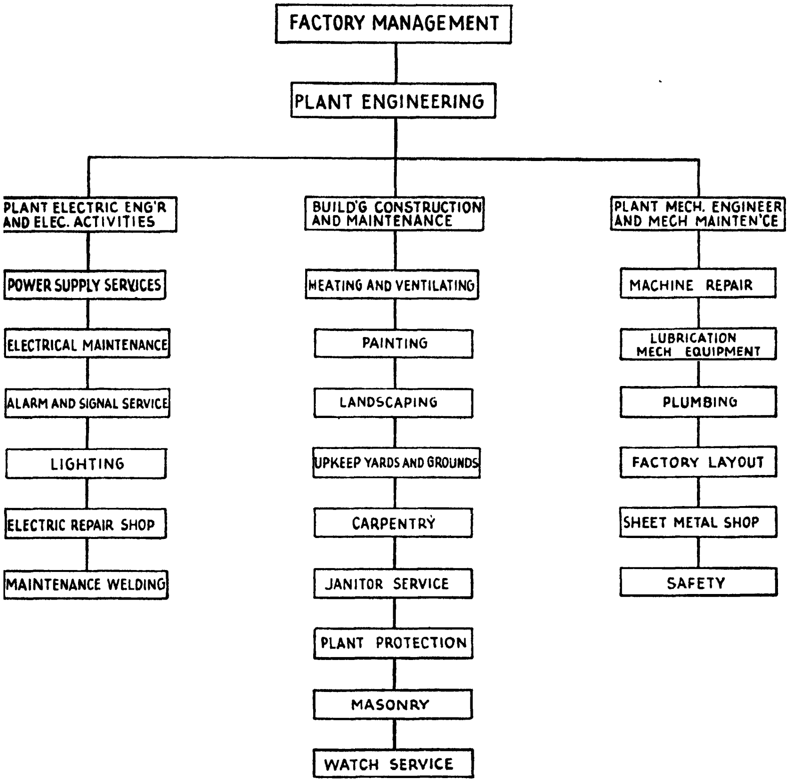

FIG. 18. DIAGRAMMATIC PRESENTATION OF A MAINTENANCE DEPARTMENT IN AN IRON AND STEEL WORKS

wants to avoid the trouble of discussing the matter with higher authority. Besides, a large repair account is usually economical in the long run.

For the continuous system of supervision to work efficiently it is essential to have a very carefully selected store of spare parts kept in such order that not only can each spare part be easily found but also will be in such a state that it can be used immediately with the minimum of preparation or adjustment. In this connexion protecting the spares against corrosion is of special importance.

Whether and which parts will be necessary can be best decided by close co-operation with the supplier of the plant or the machine, and especially with the production engineer or foreman responsible for the correct working of the plant; but as both are obviously inclined to put their demands as high as possible the maintenance engineer should know from experience how far he has to give way to their demands, for overinvestment in the stocks of spare parts, unemployed capital in itself, should be avoided.

A mistake to which attention may be drawn and which can often be found in practice is to manufacture spare parts in the maintenance shop or in other suitable parts of the works, though they can be delivered cheaper and generally of better quality by the original supplier or by another factory better equipped for the particular kind of work involved. The maintenance shop is and must remain only a repair shop rather than an independent factory of new machinery.

An order to the Maintenance Department should be prepared, planned, and progressed in the same way as production orders are prepared for the main workshops. It is a mistake usually arising from mental inertia on the part of the maintenance engineer to declare that these jobs are not suitable for a careful preparation in the Drawing Office as well as for estimation and observation in the Planning Department. This is nothing else but transferring something that is the duty of the maintenance engineer to the foremen, with the result that the planning and preparation is done worse and more expensively, because it is done by people less trained for this kind of work.

In speaking of the planning of maintenance works, not only should a programme of work be established but also an approximate time-table should be drawn up. This is often stated to be an impossible demand as nobody can foresee how long any repair job will take. It may perhaps be claimed that when overhauling a machine tool it may be unexpectedly found that a bearing has to be replaced or some other part will be found to be defective which cannot be inspected before the machine has been taken to pieces. This is only half the truth. It may be admitted that it *can* be the case, and when it happens an addition to the originally fixed time must be made, exactly as in the production proper when something unforeseen by the calculation must be carried out; but again it can be stated that these surprising cases of additional work will disappear as the continuous supervision of the maintenance of the whole works becomes more and better organized.

On the other hand, it is sometimes concluded from the fact that a certain anticipation of the working time of repairs is possible, that a piece-work system of wages could and should be introduced, at least in so far as these jobs are done in the machine shop, which forms an important part of the Maintenance Department. If exceptions are disregarded experience has, however, shown that a system of piece-work wages cannot be recommended for maintenance jobs. The reason is not only the difficulty of determining in advance the exact time of duration of the work—the estimation mentioned before may be accurate enough for planning purposes, but not as a basis of piece work—but first of all it is almost unnecessary to give any additional incentive to the men doing this kind of work. The men in question are, or at least should be, the élite of their trade—the best fitters, turners, electricians, etc., who can be found in the works—for they have to carry out very responsible and, because of its variety, mostly very difficult work; they must, further, be men of good and reliable character and as they know that the work of their mates in the production workshops depends on their own work, they will certainly do their best. Considering these working conditions, it is usually preferred to pay these men at a fixed hourly, daily or weekly rate, but of course at a rate above the average and adapted to their high standard of skill and character.

It is almost unnecessary to mention the siting and building of the machine shop which forms perhaps the most important part of the Maintenance Department. What has been said about production workshops generally is also true of the maintenance machine shop. Only one observation needs to be made, which unfortunately obtrudes itself only so often upon the experienced visitor: The machine tools are frequently a museum collection of those which can no longer be used for other purposes, but are considered suitable for maintenance work, because only repair jobs will be carried out on them, and polite, interested questions as to the age of these venerable relics will time after time be answered by "unknown—we bought it years ago, secondhand." There is no question that this attitude is absolutely wrong. Repair work frequently needs extreme accuracy, which either cannot be obtained on out-of-date machines or can be obtained only at unnecessarily high costs.

Other problems arise when maintenance workers are scattered either singly or in gangs all over a works which may be covering an area of many acres. Supervision is usually difficult and often gives the so-called "organizer" an opportunity for uneconomical over-organization. Certainly some programme should exist for these men and occasional control must be carried out by the foreman or the maintenance engineer; but by the nature of the job the long distances to the work-place may be inevitable, and to press for accurate time-tables will be silly. One must depend on the goodwill of the men to do their best and not waste any time, and therefore a very careful selection of these men is of special importance. Attention should be given to the problem of what tools the maintenance workers should have; it is not rare to find after a gang's arrival on site to carry out repairs that the essential tool is either forgotten or in a bad state. Tool-boxes, containing a carefully selected kit of tools, should be provided to suit the usual work of the gang or the man. The boxes should be of a reasonable size and weight and have shaped positions for the tools usually carried, and a list of these tools should be gummed in the lid. Periodical inspection and repair should be insisted upon to keep them in good order.

It is clear that a clerical system is necessary for recording the material used for maintenance work, and the time spent on each order carried out. As the men are working throughout for an hourly or daily rate it is easy to calculate with sufficient accuracy the costs of each order and to compare them with the estimate made beforehand. A clerical system should always be as simple as possible in any case, and it is of special importance that this should be so for maintenance work. It should also be adapted to the particular circumstances in which the men have to work, especially those outside the machine and repair shops who have to work on the plant itself. Some record of what has been done, of the materials used and the time taken, must be made; and the temptation is to ask for this record to be made on the loose order sheets issued to each worker or gang charge-hand and of which a copy is kept in the office. It cannot be denied that this saves some copying and duplicating work, but experience has shown that it is usually better in cases like those which are here discussed to adhere to the old-fashioned method of providing each workman or gang charge-hand with note-books or diaries for record purposes. Two books are used for each gang or workman, the one being kept in the office, the other being issued. The books are changed at the end of each week so that the office can extract what has occurred during the previous week without disturbing the continuous book-keeping by the men. The book may be fitted with a pocket for keeping as long as necessary the order sheets the owner of the book has received.

If this method is adopted, the handling of loose sheets by the men is reduced to a minimum and this is an improvement, especially having regard to the conditions under which the men have to work; it gives a continuous report of work done by the men which they will always recognize as correct; a report, moreover, from which conclusions can be drawn which are as near to the truth as possible, in spite of the comparatively little supervision possible with this kind of job. This report contains a continuous survey of a man's daily work which does not have to be compiled from a number of loose sheets, and this gives the experienced foreman a direct help in control which he will greatly appreciate. It may perhaps be necessary to repeat that these remarks apply to the work of men who are above the average in skill and character and who are trustworthy in so far as they will do their best to give really true reports.

The Tool Room

Another auxiliary workshop which will be considered more in detail, because of its importance and the practical difficulties arising in its organization, is the tool room. Some of the subject-matter is repeated in and belongs in principle to Part V of this book, "Economic Control." It seemed, however, impossible to avoid this overlapping and yet deal with the various problems in such a way as to give a general indication of how much detailed work can and should be done in order to keep the "tool account" within economic limits. It is often not the large investments in new machinery or the introduction of revolutionary methods of production which mark the work of the successful production engineer, but rather the unobtrusive changes in the existing organization.

Tools are often small and individually inexpensive, and where the industrial employee is surrounded by expensive plant and equipment the impression may easily be gained that a lavish use of these auxiliaries does not matter. On the other hand, particularly in large works, the man who buys the tools may think along different lines from the man who uses them, with the result that low first costs may be regarded as of a greater importance than suitability for the job. If, as often happens, the costing system does not clearly indicate how this conflict of technical and commercial viewpoints may be reconciled, unnecessary expenditure may result or the quality of the product may suffer.

As already mentioned, no attempt can be made to determine generally what items should be classed as tools, since the production methods in various shops are so different. The distinction between tools, instruments, apparatus, and machines is so uncertain and the demands on one and the same object in various works are so numerous that a general classification is impracticable. This does not mean, however, that such a classification is unnecessary for a single concern. On the contrary a strict rule must be made in each case that something which is classified only as a tool must invariably be regarded as such in the future. For example, if a chuck used in a lathe is once classified under tools it must not be considered at another time as a part of a machine, even if it can be used only for one particular machine. This distinction is important because, as a rule, tools and machines are dealt with differently under the costing system. Similar questions arise when measuring and other instruments are classified. A reasonable settlement of such questions can usually be made on the basis of a knowledge of the technical process for which the part in question is used. It is therefore a mistake to leave such decisions entirely to the discretion of accountants. Where any general or special tools are mentioned here, these are only examples, which may or may not be applicable in any particular case.

Generally speaking, tools may be divided into two groups; tools for the individual workman and general tools. The first group may be subdivided into two parts; tools for performing actual work, such as hammers, chisels, files, and spanners; and measuring instruments, such as calipers, micrometers, and rules. The old custom whereby every workman owned his own tools and consequently the employers were not responsible for them at all has been largely abandoned in modern works. All necessary tools are now supplied to each man, and in most cases a list is provided showing the types and number of tools for which he is responsible. Drawers or boxes with locks should be at the disposal of the men, in which they can keep the tools when they are not actually in use. It should be the duty of the foreman to ascertain from time to time that the tools are stored in such a manner that they are always ready for immediate use. Everybody who is aware of the usual working conditions in practice knows how seldom due care is exercised in this respect and what damage to the tools results.

Tools in General Use

To the category of tools in general use in the shops belong those subjected to comparatively heavy wear, which must, therefore, frequently be changed; expensive tools which cannot be made available in large numbers for reasons of economy; and tools for special purposes which are required only occasionally. They include tools for performing operations, such as screw dies and pneumatic hammers, and measuring instruments such as precision gauge blocks, to give a few examples. It is not possible to lay down definite rules as to which tools should be considered as individual and which as general. This cannot be decided arbitrarily even for a given factory, but must be considered separately for each shop or each special case. Once reached, however, the decision should be carefully observed in practice.

Attention may be drawn here to the difficulty of determining whether some measuring instruments, such as microscopes and weighing and measuring machines, which are often costly but are not exposed to great wear, should be considered as tools. The expenditure involved will often lead to these items being classified as machines in spite of the fact that their characteristics are rather those of tools. Another group of general tools comprises dies, punches, formers, fixtures, and jigs of all kinds, which are used only for special operations, on particular workpieces, either for forming them or for holding them correctly in position. These tools for general use are kept in the tool stores, and the method of control commonly adopted involves the use of tool checks bearing the check numbers of the workers who borrow the tools from the store. A tool check takes the place of a tool in the rack, cupboard or drawer, where it is normally stored, and a counter tool check, indicating the type and size of the tool, is hung up on a rack in the store. Thus a complete record is kept without any system of book-keeping. The rule commonly established in connexion with this system, that all borrowed tools must be returned at the end of the week unless the foreman gives special permission to the contrary, is frequently neglected in practice. Failure to observe this rule, however, may lead ultimately to the loss of valuable tools.

The Shops' Tool Requirements

The shops' tool requirements are made known to the Purchasing Department or the Tool Store—preferably the latter—which if necessary forwards the request to the Purchasing Department by requisition notes, which can be issued either by the shops concerned or by the Planning Department. It may be regarded as a sign of over-organization if the first alternative is ruled out, because the efficiency of the Planning Department is never so high in practice that a direct order from the shop is invariably unnecessary. On the other hand it should be the duty of the Planning Department to prepare the requisition notes for tools as far ahead as possible, particularly when special dies, fixtures, or jigs are required.

As soon as the need for the tools is known and it is found that it cannot be satisfied from the stock in the stores, the very important question must be decided *whether the tools shall be bought from outside suppliers or produced in the Tool Room.* Here economic considerations should decide the issue. The term "economic," however, does not refer to the price alone, but also to the quality and to the date of delivery, factors sometimes having a greater influence on real economy than the money to be expended. Thus the decision should not be made by those concerned with purely commercial matters without consulting the technical man who will afterwards be responsible for the delivery, quality, and costs of the saleable product or goods. It is one of the weak points of many organizations that this close co-operation is often lacking. On the other hand there is sometimes a desire on the part of the tool-room manager or even the works manager to undertake this kind of work, even if it is obvious that an outside factory could do it better, quicker, and cheaper. The excuse often put forward, that the alternative involves the disclosure of manufacturing secrets, is usually so absurd that it does not require to be refuted.

Tool Costs

Although the question of tool costs belongs actually to Part V of this book, "Economic Control," it is so closely connected with the problem under discussion that this will not be properly understood unless some reference to costs is made here.

Accurate comparison of tool costs should be made in all doubtful cases. When buying from outside sources, the purchasing charges must be added to the invoice price. They comprise the costs of transport, storage, administration of the Purchasing Department and of the Receiving Depot. The costs of inspection after receipt should not be overlooked, particularly where special tools are concerned. If the tools are produced in the works the costs are those of material, wages, and overheads in the Tool Room. If parts of these tools are bought from outside the works concerned, as is frequently desirable, such parts may best be treated as material and priced in the manner described above for complete tools purchased from outside.

As this comparison of tool costs may be of great importance it should be insisted that the Costing Department should have the basic figures easily available so that the calculations can be carried out correctly and quickly. There will be an opportunity of returning to this point later on.

It is advisable that all new tools should be charged first to the Tool Stores and then from the Tool Stores to the Production Department, even if they are to be delivered directly to the latter. This may seem to be an unnecessarily roundabout way, but it has proved so useful for statistical and control purposes that the extra clerical work can be considered as insignificant.

The question of the *allocation of tool costs in the internal costing system* is not always treated with the necessary clarity and consistency. The costing system has to take account of the supply of tools from the stores, the return to the stores of tools no longer being used in the shops, and the repair of tools.

The usual method is to book the value of a tool supplied from the stores to the overheads of the department to which it is allotted. This department thereby becomes the owner of the tool, and is charged with the total amount of the costs in the period during which the tool is received. As later explanations on "Economic Control" will show, this is not strictly correct since tools have frequently a longer life than is represented by this period. The more accurate method of depreciation over a series of periods, as applied to machines, is too complicated for these mostly less expensive and therefore less important objects. The mistakes made in this way are considered, in general rightly, as within the errors inevitable in any costing system, which is in any case always a method of approximation.

Another question is: What is to be done if one shop borrows a tool which has become the property of another? The conscientious foreman will rightly object to giving away the property of his shop without receiving any credit for it. As the tool is used, however, he cannot expect the full cost with which his shop was originally debited. It would be too difficult to estimate in each case the correct value and it has proved satisfactory to apply deductions of certain percentages varying with the age of the tool, which should be determined once and for all according to the particular working conditions.

The cost of tools can be considered as a part of one particular work order if it is certain or at least probable that the tool can be used only for this order and will be worn out and useless after the order has been completed. If it is known that, say, 10,000 pieces can be produced in a die, one ten-thousandth of its costs should be allocated to each part produced in it. Finally there are cases where the cost of a special tool can be charged directly to the customer, and the simplest method is then to include the item in the customer's order costs, or to treat the manufacture of the special tool as a separate customer's order.

The Return of Tools to the Stores

The return of tools to the stores, because they are no longer required in the shops, should be treated in a similar manner to the borrowing of tools by one shop from another. When the tool is received in the stores, however, it should be separated from the new tools of the same type if a lower value has been given to it. This is not quite so simple as it sounds, however, because, as everyone with experience knows, sometimes a used tool which has proved itself capable of performing the task required of it is of more real value than a new unproved one.

The Reconditioning of Tools

The reconditioning of tools can be done either outside or in the firm's repair shop. For example, it is usual to send files to a special factory for recutting, but to regrind drills, cutters, and reamers in the works. Further, it must be clearly laid down whether the tools should be returned to the stores for repairing, or whether the tools should be repaired in the shop itself before they can be used again. If the tools are returned to the store, it is better to wait until a sufficient number of tools of a similar type can be collected, so that the repair work can be carried out in a more economical manner than with a small number. The sum of the repair costs and the values with which the shops returning the tools have been credited form the new value of the repaired tools in the stores, provided that this sum does not exceed the original or the market price, in which case the lower value must be used. If, however, the tools are to be repaired in the shop where they have been used it is usual to include the costs in the overheads. This is done for repairs of a minor character only, such as the replacement of a broken screw in a jig. For a more important repair a special works' order must be made out and the work entrusted to the Tool Room or an outside factory.

The tool account of the shop in question must be debited with the cost of this works order.

Design of New Tools

There are two questions in particular which should be decided before the design of new tools, such as form cutters, broaches, dies, and punches is begun—

(1) What is the number of workpieces which will probably be produced in a given period of time?

(2) What degree of accuracy is required for these workpieces?

The answer to these last two questions will determine to a large extent (*a*) the choice of the material used for the new tool; (*b*) the form of the tool; (*c*) the production methods to be employed.

A few examples may serve to illustrate these points. Obviously, drills made from high-speed steel or tipped with cemented carbide should not be used when the diameters are so small that the life of the tool is governed by breakages rather than wear, or when the machine does not permit of the high speeds appropriate to the more expensive drills. Dies for the production of a relatively small number of workpieces can possibly be made from cast iron instead of highly valuable steel. A progressive die as used for the mass production of a complicated blanked and formed piece can advantageously be replaced by a series of simple tools—some of which may possibly be adapted from existing designs—when fewer pieces are required.

Expensive jigs, rightly used even for a comparatively small number of parts if high accuracy is required in the spacing of holes, should not be provided when wide tolerances are allowed. In such cases, the use of simple templates or even the old-fashioned method of marking off may prove more economical. Sometimes changes in the design of the workpiece may reduce the initial or maintenance costs of the tools considerably. Thus an increase of some radius by a small fraction of an inch may remove the danger of fracture. In this connexion special attention may be drawn to the tendency of some draughtsmen to call for small tolerances on workpieces. The case of a well-organized factory comes to mind, where a consultant offered to work for some months without any other fee, if he was allowed 10 per cent of the savings obtained by correcting unnecessarily fine tolerances. The reasonable application of standardization may also have a pronounced effect on tool costs.

In this connexion what has been pointed out earlier may be remembered about the relation between Workpiece Design and Tool

Design and their separated drawing offices respectively, as well as about the relationship between Design and Production generally.

The Inspection of Finished Tools

Finally some hints may be given as to how tools should be tested in the works and stores when not actually in use. It has already been mentioned that the inspection of the finished tools is extremely important, whether they are bought from outside or produced in the Tool Room. It has proved advisable to make the designer of the tool responsible for this inspection, if this arrangement can be fitted into the organization. Not only has this inspection itself to be carried out correctly but careful records must be kept of the test results and filed for later reference in case disputes of any kind should arise. The tests should be performed under conditions as similar as possible to those in which the tools will be used in production. Such testing, of course, involves expense, but this is negligible in comparison with the heavy losses which may result from the use of a single jig with a slight error in the centre distance between a pair of holes.

The storage of tools should follow the same rules as the storage of material generally. Expenditure on storage accommodation of modern design is not wasted, because of the ease of inspection, smaller space occupied, greater orderliness, and better protection against dust and rusting which is afforded. These remarks do not refer only to the general Tool Stores but also to the stores or "cribs" maintained by each shop for its own tools. Each such shop store should be equipped to do minor repairs and maintenance while tools are stored between jobs, and it should be placed in the charge of an experienced and trustworthy supervisor who may be an elderly fitter or toolmaker, or a war invalid with sufficient professional experience. Major repairs, of course, must be left to the Tool Room. Some large works with many shops and a series of shop tool stores have with considerable success placed them under the authority of the Tool Room Superintendent. It was found that in this way the interchange of tools between the various tool stores or cribs was facilitated, the number of tools stored was reduced, and those in charge of the shop tool stores were able to take advantage of their mutual experiences.

Some of these cribs or stores should be provided with the necessary equipment, so that cutting tools, drills, cutters, saws, etc., can be resharpened as often as necessary. It may be regarded as a sure sign of a modern workshop if this regrinding of tools is centralized and no longer left to the individual machine operator. There is still some opposition among the men to this practice, but the advantages are now so well known that they need not be emphasized here. In connexion with the regrinding and the touching-up of tools, it should perhaps be pointed out that care must be taken when supplying and designing tools to ensure that sufficient material is provided to permit of a reasonable number of reconditioning operations. Finally the importance must be emphasized of issuing sensitive measuring instruments and accurate cutting tools with sharp edges in suitable boxes or covers, and of ensuring not only that they are returned in these boxes or covers but that they are also kept in them unless actually in use on the machine.

Here the discussion of the material factor in the production proper may be concluded, although it can be by no means considered as exhaustive. The object has been rather to give a general outline of how these matters should be considered from the point of view of economics and how much detail work can and should be done in this respect.

CHAPTER XXI

THE HUMAN FACTOR IN PRODUCTION: WAGES

WITH the following chapters this book approaches problems which have become more and more important since the beginning of the present century and to which the growing generation of technical and administrative personnel have to turn their attention, the more so since in the past mistakes were made in dealing with the human factor, mistakes which have left their mark on factory life and which still render difficult the relations between workers and management, employers and employees. As a matter of fact, wages, one of the most important problems, has already been discussed to an extent considered sufficient for the purpose of this book, but how to tackle the administrative side of the remuneration of the employees, and especially the workers, has still to be explained. The department which deals with this work is generally known as the Wages Office, and it is outside the scope of this book to go into the details of the various book-keeping systems used. All that can be done is to give the general principles that all good systems should possess and to enable answers to be given to the many and various questions which the general or works management may put to the Wages Office daily and even hourly.

The Booking of Wages

The work may be divided into (1) the booking, which is done in the shops or at least in the closest possible connexion with the shops, and (2) the work done in the office on these cardinal facts and figures, so that wages can be paid and the necessary statistics and other information obtained.

The Booking of Wages in the Shops

The question of how to do this best has found different answers in different works and it would be futile to start discussing the various methods used, because their merits and demerits depend upon the circumstances of the case in question. It may even be that in the same works one method is used in one shop, another in another shop. This is not a case of carelessness or laziness, but is done deliberately, the method best adapted to the peculiarity of the workshop in question being chosen. Of course, such a difference in the organization of so important an arrangement as the booking of wages in the shops should always be questioned and the conditions carefully examined to make certain that the advantages claimed are real and not imaginary.

Two General Rules. To-day it is nearly always considered essential to take booking away from the worker as much as possible. The more this is effected, the less the worker will be hindered in his proper work and the better and the more reliable the information will be; for the hand accustomed to the use of tools and the precise adjustment of machines and instruments is frequently not very good at writing. It is often the best craftsmen who show an aversion from writing, not only because supervision may be disliked, but also because the worker considers writing the duty of a clerk and unproductive in comparison with his own.

There is a second equally important rule: The worker should know that no work can be paid for unless a written order can be shown. This second rule is important because it is only on the basis of this order that the wages can be booked completely and correctly. Suitable printed forms should be used so that the order contains all details necessary to enable the wages to be properly booked in the first place and for the work done to be identified later in the Wages Office. The collection of all the facts and figures then becomes a comparatively simple job, needing only the care and attention which can be expected from any, even a very junior, employee.

It is a matter for the organization of each individual works to decide whom to make responsible for writing out the orders to the workers; previously it has been suggested that the Planning Department is very suitable. It should be pointed out, however, that the one man who should not be considered for this job is the very one who is so often chosen for it, especially in small or medium-sized works, and that man is the foreman. His job is the supervision, organization and distribution of the work to his workers; he has to keep order and discipline in the shop and not spend his time in his office writing out orders. The foreman should receive these orders in such a state that he has only to write in the name of the worker who has to carry out the job.

The Diary. This is probably the oldest system of booking the wages in the shops and has been described for the control of maintenance workers (pp. 192–3). If it is used for booking wages it is usual for a clerk from the Wages Office to go round the workers and enter the finished orders in the diaries, which he then stamps or signs and returns to the Wages Office where they are kept finally for control purposes.

The Wages Ticket. A more modern method of booking wages is the use of wages tickets, one for each operation or process. The idea is to diminish the amount of writing by making the work ticket serve for the wages as well by adding information about time and the cost of the work to the work ticket. At first glance there is an appearance of greater simplicity; but this advantage is not so great as it seems to be, for the total gross earnings of any worker during a wages period, usually a week, must be determined by collecting all the wages tickets—finished, unfinished, and continued from the preceding period—on which the worker has worked, and summarizing them in such a way that the worker can easily follow and check it. This summary should be handed to the worker either with his wages or some time before, and is not, in the long view, very different from the diary method of booking wages, and probably entails more office work; but it must be admitted that the wages ticket is to be preferred to the diary because of its greater mobility.

Combining the Wages Booking with the Routing Card. A workpiece is not often subjected to one operation only. Usually it goes through the hands of a number of workers in order to be, say, ground, planed, and filed. An order and a wages ticket are necessary for each of these four processes and as both order and ticket must have about the same wording on them it is suggested that to diminish the clerical work they should be combined into one ticket which should accompany the workpiece from operation to operation in the same way as, and in fact it may take the place of, the routing card. This proposal has been used in practice and been considered useful in many cases, but many disadvantages must be taken into account. If the routing card becomes the order to carry out the various processes, but not in any sense a wages ticket, it will be necessary to keep a diary for booking the wages. In this case, the difficulty arises that the workpiece, which should never be separated from its routing card, must be kept back at the end of each operation until the entry of the wages into the diary has taken place. This may either cause production to be delayed or the worker must be permitted to make the entries into the diary himself, and then to send workpiece and routing card on to the next worker. The disadvantage of this procedure has already been explained.

In addition the routing card is not only the order but becomes the basis of payment and the sole document for both purposes. Therefore the work done by the first worker can be booked and his wages calculated only when the whole work covered by the routing card has been completely finished and the card has been returned to the office. This may take a long time, even some weeks. The worker may not lose anything by this arrangement, as payment is only deferred and not altered in any way, but the position of the works being indebted to the worker should be avoided as it is poor psychology and is apt to lead to practical difficulties—for instance finding out the amount due to the worker who wishes to leave or is dismissed at short notice. In order to avoid these disadvantages all routing cards have to be collected at the end of every wage period, usually weekly, and sent to the Wages Office who have to do the booking from them. The unfinished routing cards are then to be returned to the workers and shops concerned—all this in a very short time, because the routing cards cannot be collected until late in the wage period and have to be returned early in the next.

Special difficulties arise when using routing cards as orders, whether or not they are also used as wages tickets. This is best illustrated by an example. One thousand bolts have first to be turned on a lathe, then a split-pin hole drilled, and finally an oil groove has to be milled. The work on the lathe has just started when word comes from the office that fifty bolts are needed urgently. As soon as the fifty bolts are finished on the lathe, they are passed on to the drilling machine and then hurried to the milling machine. What should be done with the routing card which has been made out for the production of 1000 bolts and—according to rule—should not be separated from the workpieces? This hurried finishing of a partial quantity, which of course should always be an exception but cannot be avoided completely, especially in times of shortage, clearly makes difficulties and leads to such trouble in wages booking that it invites errors and even deliberate fraud. A further unavoidable disadvantage of this system is the difficulty of making the routing card clear when combined with wages ticket or order, and this makes the office work on them very laborious.

All these circumstances make the multiple use of the routing card, which seemed so practical in theory, very inconvenient in practice, and almost without exception the system has been abandoned soon after its introduction. The usual arrangement is to keep the routing card and the work order forms as separate documents and to book the wages either by diary or by some wage ticket system. For the sake of simplicity the following explanation deals only with the wage tickets, but the same principle can be quite easily adapted to the diary system.

Dealing with the Wages Ticket in the Shops. The distribution of the work to the worker is the duty of the shop foreman; he has to put on the wages ticket sent to him by the Planning Department the name and control number of the workers to whom he issues the work; the reckoning up and booking should not be done by the foreman but by a clerk of the Wages Office. Experience has shown that it is advisable to place this clerk in the shop, for which he or she has to work, preferably in the foreman's office. The clerk has to do all the writing required of the foreman and has to adapt himself as far as possible to the situation of working with, without being responsible to, the foreman as his superior. The clerk is, as already mentioned, not the subordinate of the foreman, but an employee of the Wages Office. It has to be admitted that this peculiar position requires considerable tact, for such clerks may have been subordinate to the foreman, and have then been put, by a change of organization, under the control of the Wages Office without changing either their work-place or their actual work, but practice has shown that the initial difficulties soon disappear. That this change of organization was necessary is, however, clear, for only one department should be responsible for dealing with the considerable sum involved in the wages, and it is obvious that the foreman is not a suitable person to supervise this office work; apart from any other considerations he has enough to do in looking after his shop, the job for which he was made foreman.

It is also the duty of the clerk to see that each worker has only one wages ticket at a time, namely the ticket for the work he is actually doing. The only exception is if a worker is operating more than one machine at the same time, when he should have as many wages tickets as he has jobs to do. It is not easy to carry this out in practice, but it is possible and it has been proved the simplest and surest means of putting in order the whole wage system, especially in preventing the concealment of the time taken when on piece work, a practice which makes the automatic control of the accuracy of the piece-work prices impossible and which may be considered as a canker in our workshops. It is of course the duty of a foreman to determine how the jobs are to be distributed to the workers, and, under the general direction of the Planning Department, the order in which they are to be carried out. If the foreman marks the wages tickets accordingly, the clerk can keep them in order and issue them in proper sequence to the workers. It is the rule that no worker receives a new ticket before he has returned the old one, either because it is complete or because it has had to be interrupted for some reason or other. The total of the time booked on all wages tickets in a given wage period, say a week, should coincide with the total working time as given by the "clock-cards" which are almost universally in use and have to be marked with the time of entry and leaving at the gates of the factory.

As a summary has to be made of all work done or started during a wage period, giving the time spent on each job, a suitable form—termed the "weekly work sheet" if a week is the wage period—is made up in duplicate by the workshop clerk in such a way that it shows the gross earnings of the worker for the period in question. This may be done either in time or money according to the methods in use in the works. If overtime has been worked, it will be indicated on the clock control cards and must be expressly noted on the summary, and the special remunerations which are given for overtime must be included. This summary has to be delivered to the Wages Office together with the wages tickets as vouchers, immediately after the end of the wage period. It happens frequently that a job is incomplete at the end of the wage period and so the wages ticket has to be continued on into the next wage period. In this case the clerk has to make out an instalment sheet so that the work done is recorded. The situation is a little more difficult if piece work of some kind is in operation, as the clerk has to pay careful attention that the total of all instalments paid for one wages ticket does not exceed it in value. To avoid this possibility it is usual for the Works Management to fix a percentage of the value of the wages ticket—say 75 or 80 per cent—which the sum total of all the instalment sheets must not exceed, unless it has first been referred to the foreman, who has to determine in agreement with the Planning Office and/or the Works Management what has to be done. For the rest it can only be recommended that payment in instalments be avoided or reduced as far as possible, and how far this can be done depends to a large extent on the care exercised by the Planning Office in keeping the amount of piece work on any one ticket within reasonable limits. It is, however, impossible to do away completely with instalments. It may even happen that a piece-work wages ticket may have to be done in several instalments, either because the work itself is such that it cannot be subdivided and needs several weeks to complete it, or because unexpected conditions in the workshop cause a normal piece-work ticket to be interrupted a number of times. In these cases only increased care and attention in booking the wages will avoid mistakes and the consequent irritation to both workers and management.

The whole procedure will become more difficult in the case of group piece-work wages: The total sum of wages is charged to the leader of the group and share sheets have to be given to the workers forming the group. Obviously, instalments may become necessary also in this case, and form a further complication, having disadvantages which must be very seriously considered if there is any question of introducing group piece work.

Looking back on the whole question of booking the shops wages and considering its very great importance, it is clear that the clerk doing this job cannot be a person content to work mechanically. This fact has sometimes led to the conclusion that it is doubtful whether the whole arrangement is practicable, but experience, collected especially in medium-sized to large works, has shown that the contrary is the case. There are plenty of male and female clerks—especially the latter—who can do this work very successfully. They need to be carefully introduced into their not very easy task and it should be made clear to them that they have a considerable influence on the all-important relationship between workers and management, that patience and tact besides care and firmness are necessary if misunderstanding arises, and that any disagreement has to be cleared up and can never be settled by hushing up. It is, therefore, also very important to see that these clerks have good supervision, which, like all good supervision, should be less a matter of discipline than of seeing that subordinates receive proper backing, encouragement, and advice whenever necessary. In this respect it has proved helpful in works of some size, where a fair number of such clerks are scattered all over the works, to choose an elder and more experienced employee of the Wages Office as supervisor of the clerks in the workshops. He has to go from shop to shop, to give advice, to clear up obscurities in the accounts, to keep order and discipline among his subordinates, and especially to see that friction between clerks and foremen does not occur. In the author's experience this arrangement is preferable to the alternate proposition sometimes made, that these clerks should be concentrated in one place, generally the Wages Office. The suggestion is usually made on grounds of economy, but when examined more carefully it will only too often be recognized as a self-deception. The foreman, who is rightly opposed to doing the clerical work himself, but of course can never do without it, is only too easily inclined, if clerical help is refused officially, to exercise the resource and initiative which were among the qualities that got him his job, and to obtain clerical help privately, by using a suitable person working in the shop, at first only for a few hours. This time gradually grows longer, however, and presently one is confronted with the fact that a "clerk" has been created—usually indeed in unsuitable form—and instead of the suggested economy there is an increase of cost. This, however, is not all: The dispersal over the whole works of the clerks subordinated to the Wages Office has the further advantage, which cannot be overestimated, that the wages book-keeping is kept in continuous close connexion with real life in the shops and that it avoids rigidity of the bureaucratic apparatus, which may only too easily be the consequence of concentrating the booking of the wages in one place.

Function of the Wages Office

It is the duty of the Wages Office to collect all wages tickets, clock-cards and other vouchers used in the shops for recording working time and wages, to see that they are all properly kept, and to draw the necessary conclusions from the figures and dates they contain. It should be the rule in each business undertaking that all accounts of the nature of those coming from the Wages Office, i.e. concerning sums of money, are to be calculated and checked, especially if finally such large sums are concerned, as in this case. This rule should never be disregarded as a superfluous and merely cost-increasing measure, as it has sometimes been. As soon as the accounts have been checked in the office the clerks in the shops are finally discharged of their responsibility, which is thus transferred to the Wages Office. The weekly summary sheet, of which two copies are usually supplied to the Wages Office, is there used to calculate the net wages of every worker. This is done by deducting from the gross wages as given by the summary sheet such items as income tax, national insurance, national savings contributions, repayments of loans from the works, and payments for special services such as rent, if the works own houses which are let to its employees, etc. While the first two of these deductions are fixed by law the others depend on voluntary agreements which may be made by the workers and the works in question. Care must, however, always be exercised in making deductions from wages that the body of legislation known as the Truck Acts is not infringed. These enactments were designed to protect the employee against the unscrupulous employer who, instead of paying wages in cash, paid them in inferior goods valued at exorbitant rates, which the workers were compelled to take instead of cash, under threat of dismissal. Prosecutions under the Acts are rare to-day; but a firm which, for example, charged its canteen meals by deducting a fixed sum from its workers' wages might find itself infringing the law.

The Wages Office also plays an important if indirect role in the relations between the workers and the Management; for the confidence of the workers is based to a great extent on the correct payment of their earnings, and it is only natural that the work of this office which is responsible for their payment, should be subject more than any other to criticism and comment, since too many errors may give rise to suspicion and ill-feeling.

Despite these considerations it is sometimes found that the organization of the Wages Office is built up in a rather haphazard manner. Improvement can be made only if there is a clear understanding of the functions of this office.

The main and obvious function of the Wages Office is the preparation of the pay roll[1] for the preceding wage period—usually a week—by entering the net earnings, taken from the summary sheets of every worker on the wages list, against the name of that worker. It is usual then to present the pay roll to the Cashier's Department who provide the necessary coin and notes, which must be in the correct proportions to enable the pay packets to be filled by the Wages Office and given to the workers on pay day. This is usually the first Friday after the wage period in question.

The pay roll, formerly a bound book, is to-day nearly always made out on loose-leaf sheets, which are bound only after the conclusion of the current year, half-year or quarter. It is, of course, inconvenient and time-wasting to be forced to write out weekly the whole list of names of the workers. To avoid this, duplicating methods, especially the addressing machine, have been tried, but full advantage from these methods can result only if no frequent change of workers from one shop to another occurs and if the labour turnover is small. However, the preparation of the new pay roll always occurs during a comparatively quiet time—one pay is over and the next cannot yet be started—so that there is usually plenty of time to get it written out. In any case the pay roll in the usual form gives a clear and accurate statement by the Wages Office to the Cashier's Department of the amount of money needed and how it is distributed to the workers. It is nearly fool-proof and, with no more than ordinary care, can be made rogue-proof, which is of great importance where large amounts of ready cash are dealt with. The column which contains the amount to be paid should be divided into two sections, one for wages actually paid on pay day, the other for wages paid previously to pay day. The reason is that workers may leave their jobs in the course of the week and have to be paid immediately. The corresponding sum must of course be included in the pay roll so that all the statistics and accounts which are based on the pay roll should be accurate, but as this sum has already been paid in cash it should not be included in that sum which has to be distributed in cash on pay day.

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[1] See *Pay-roll Methods*, published by British Standards Institution, 28 Victoria Street, London, S.W.1, April, 1944.

As each shop or gang under one foreman is usually paid separately, the pay roll is divided so that the totals for each shop or gang can be obtained. In large works this leads to summarizing all the pay rolls into a "wage-review" and using this document to obtain the cash to pay the wages from the Cashier's Department.

The pay roll should contain such details copied from the weekly summary sheets as: each man's trade and the total hours worked, divided into hours spent on piece work, hours spent on fixed hourly rate, and hours spent on overtime, etc., for these details are necessary for many statistics that are best based on the pay roll.

This last consideration leads to the second purpose of the Wages Office: It has to provide the works manager and his departmental managers and foremen with all the statistical data they need for gauging the output of the works in relation to the wages paid either on time or piece rates and the accuracy of these rates. The actual earnings and the average earnings for each worker and group of workers per hour, per week and per year must be known for comparison purposes as well as the average earnings over all workers. The numbers of the workers, divided into age, sex, and trade groups must be known and regular returns made, stating those at work and those absent and the reasons for their absence where these are known. Details of the labour turnover must also be given as well as the number of working hours, differentiating between hours worked during normal times and hours worked on overtime, and net working times, after deducting meal times and stoppages, etc. From these data all conclusions must be drawn and issued in a convenient form in so far as the Management really needs the information and therefore asks for it; *for statistics which are not used represent unproductive work and waste of money.* In how many works are they got out year in and year out and never looked at! Most careful consideration is therefore necessary before any statistics are asked for or got out so that only those really essential are produced, and both the kind and the form in which they are produced must be chosen and adapted to the concern in which they have to be used.

The basis for these statistics is the pay roll, but there is another arrangement which used to be less often found in this country, but is now almost universal owing to the operation of PAYE income tax, and that is a card index of every worker, giving his gross, net, and total earnings, shown as a running total week by week. The figures are copied from the pay roll on to the cards and these may be enlarged to contain all the information which is on the pay roll, so that any worker's record is immediately available without reference to the pay roll. This card index is sometimes used as a muster roll of the workers, in which case it would be necessary to add personal details, such as date of birth, address, date of engagement, present occupation, wage rate, promotions, etc. These accounts have proved useful in many cases, especially in large factories, as a basis for negotiations and discussions with the workers themselves, the works' council or trade unions, and also for some statistics which may be required. Still it cannot be denied that to keep up this card index causes considerable extra work, and it is doubtful whether in many cases it would be worth while if it were not for PAYE, which makes it essential to do it in one form or another. Before these cards are expanded to contain details other than those required by PAYE, it should be quite certain that the additional work really gives additional information and most important, that this additional information will be used.

Whilst the average earnings of a worker over a given period may be of interest, and even where a piece-work price exists for the job, it is often of greater importance to know how much any job has cost. All possible care must be taken in determining a piece-work price but, with all the care in the world, it is impossible to guarantee that all circumstances have been properly taken into account, that the equipment in the shop and the worker concerned have worked according to plan, that the rate fixer has made no mistake, etc. To verify this beyond any doubt, records should be kept so that the earnings on any job may be compared with the average earnings of the worker doing the job, the amount that has been earned by others or the same worker on previous repetitions of the same job, and the average piece-work earnings on all jobs passing through the shop at the same time. Various places in the works are greatly interested in these records, the Department of Planning and Production Control, the Works Management, and especially the foreman concerned, for he will use them to confirm or modify the opinion he has formed about the worker. As all the necessary papers from which these records may be taken pass through the hands of the shop's booking clerk, he or she is the best person to keep the records, and it has proved useful to let them remain in the foreman's cabin or office for inspection by interested people.

As well as providing information to the Works Management, the Wages Office has to provide somewhat similar information to the Costing Department; the exact details will be governed by the system of economic control adopted and will therefore vary from works to works. Of course it is not only possible but even probable and desirable that figures prepared for paying the wages, for the Works Management, or for the Costing Department can be used for one or both of the others.

A large part of this work of preparing statistics could of course be done in other departments, especially in the Costing Department, but it is usually convenient to leave it to the Wages Office, who are probably well equipped with calculating machines and similar office machinery for statistical work. For the rest the Wages Office should be equipped like any others with typewriters, carbon paper, duplicating machines, etc. One method of writing out the pay packets is, however, worth mentioning as it saves considerable labour even where an addressing machine is available. The pay roll is typed on a book typewriter and a carbon copy is taken on to paper with a gummed back. The gummed paper is perforated so that each entry can be torn off and stuck on to the pay packets, so saving all the copying and checking usually needed to ensure agreement between pay packets and pay roll.

The Problem of Mechanization of Wage Booking

It is clear from these considerations that the work of the Wages Office mainly consists in the different grouping of the same figures with a view to finding sums of payment, costs and statistics of the various kinds. This can be done, and is done, solely with the use of the simplest rules of arithmetic, the first four rules as learnt in our school days. But as modern industrial works increase in size and the number of workmen employed grows, the more tedious and time-taking, the more costly and subject to error does this job become. It is, therefore, only natural that attempts have been made to mechanize this work, which seems to invite development of this sort more than any other office work. This tendency is certainly a sound one and any proposal made in this direction is worth serious consideration. There are, however, some dangers which are often overlooked when first approaching this problem. Of these only two need be mentioned, and their importance should always be kept in mind when choosing and introducing one of the various systems which have been elaborated.

It should never be forgotten that such a system cannot be anything but a "tool" for doing the real job. It is therefore necessary first to make perfectly clear what kind of work is to be done, i.e. to build up the organization itself as if such a modern system did not exist; to find out the essentials which shall be a guide through the masses of figures which pour week after week into the Wages Office *and frequently overwork the persons responsible for the statistics. This stage of development may never have to be passed through as it* may be obvious from the beginning that the use of one of the systems of mechanization will be essential. In this case the organizer should outline on paper the whole organization in detail as if no system of mechanization existed, and *then* consider the changes necessary for its introduction. This is the only way in which to obtain good results from the organization and the best use of its machines.

This is also the best way to avoid the second and perhaps more serious mistake of allowing the system to become something more than what it should be, namely a "tool" so that it begins to govern how and what work has to be done and leads either to unnecessary complications, or—what is worse—to handicapping production itself. Although the organization should keep workmen and foremen free from clerical work, it is not—or is very rarely—possible completely to do without their help for the first booking of wages. Here the system of mechanization must work so that it neither complicates this assistance nor appears to be a useless and time-wasting routine. The best system is that which does not call for comment in the shops because it is felt that the work to be done in wages booking is the minimum possible and has been chosen solely to suit the convenience of production.

As already mentioned, a number of such systems have been devised and are in use. Only one example will be mentioned here, and it has been chosen because it is the best which the author could observe in practice, particularly in fulfilling the demands outlined above; but it should be kept in mind that it is given only as an example, and it is possible, of course, that there may be other systems equally valuable with which the author has had no opportunity to become acquainted.

The system referred to is the well-known Hollerith system, which does not need a lengthy description since its technical details have been described in many publications.[1] It is only necessary to mention here that the technical equipment consists of three machines, the hand-operated punching machine or key punch, similar to a typewriter, which is used for "translating" the figures from the original vouchers coming from the shops into holes punched in cards, the sorting machine, and the tabulating machine, both operated automatically by means of electricity, the first sorting the punched cards in any desired manner, the second totalling the figures of the individual groups and printing the results obtained.

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[1] See, for example, Wheldon: "Application of the Hollerith System to a Plant Rolling Steel Sheets and Strips," *Cost Accounting and Costing Methods*, p. 344 (Macdonald & Evans, London); or the author's "Application of the Hollerith System to a Factory of Iron Barrels," *Economic Control of Iron and Steel Works*, p. 113 (Chapman & Hall, London).

These cards, once punched, form an unchangeable permanent record; they can be mechanically sorted at any time and the information punched with them can then be added or subtracted as desired and the result printed, almost automatically, without brainwork on the part of the person manipulating the machines, and at great speed. Moreover, if for a special investigation statistics are needed which are not made available in the usual course of the work, these can be obtained with nearly the same facility as if they had been provided from the first. The basic requirement is a suitable filing system for the cards.

It is obvious that these are great advantages against the usual method without such mechanical equipment, advantages which will, of course, increase in proportion to the number of workmen, the variations of the products, and the more important and numerous the statistics the management demands. On the other hand there are the costs of the installation and manipulation of the mechanical equipment to be considered in relation to possible ultimate economy. This certainly always needs careful calculation; for the author could cite an instance of a factory with only 500 to 600 workmen, where the Hollerith system was working very economically, although it is often declared that an economical result cannot be obtained in works with less than, say, 1500 workmen.

THE ACTUAL PAYMENT OF WAGES

It is almost superfluous to point out again the great importance of using every possible care in the actual payment of wages, but it is repeated here not so much because of the apprehension that any intentional fraud may occur, as because of the psychological impression which any error may produce on the workers.

After the ready money has arrived in the office it is first counted out for each shop, care being taken that each has its proper proportion of notes and coins. That this is easily possible shows that the proportions of notes and coins asked for by the Wages Department from the Cashier's Office was correct. Two clerks start to count the money into the packets prepared in advance for each shop, the first counting out the money and handing it to the second, who checks it, puts it into the packet, and then closes it before laying it aside. Sometimes the packets are of transparent paper so that the worker can himself check the contents before opening the packet. The total amount put aside for each shop must be used up exactly, without surplus or shortage when all the packets for this shop are filled. This is a good intermediary check. The packets show on the outside the name and control number of the worker, and in some cases also the amount to be paid, and even the gross and net wages. This is considered superfluous if the following procedure is used: The weekly work sheet for each worker is written in duplicate and the bottom copy with the net wages fully worked out on it, not forgetting the deductions for PAYE, etc., is handed to the worker a few hours before the paying out of the wages. Thus he or she has a detailed explanation of how the amount to be found in the packet originates and can complain to the foreman or the workshop clerk if he does not agree with it. He signs the copy of the weekly work sheet and returns it against the pay packet as a receipt for having obtained the money. The top copy of the weekly work sheet is handed to the worker together with the pay packet and he is recommended to keep it carefully in case any questions should be put to him, for instance by the income tax inspector, etc. Practice has shown that this procedure can be considered foolproof in so far as no complaints about difference between the amount to be paid and that actually contained in the packet are possible. The signature of the worker shows that he has accepted this amount as being the correct remuneration for his work. Even the most careful auditor cannot have any objections to this procedure; as a matter of fact there are many who consider the signature on the copy of the weekly work sheet unnecessary.

CHAPTER XXII

THE HUMAN FACTOR IN PRODUCTION—THE PERSONNEL MANAGEMENT DEPARTMENT

THIS chapter is an abstract—as a matter of fact nearly a reprint—from a leaflet published by the Industrial Welfare Society (Inc.), 14 Hobart Place, London, S.W. 1 (second edition, April, 1946), to whom the author is greatly indebted for permission to use it to such an extent. There is no question that this chapter touches in some cases matters already dealt with in another connexion as the job of other departments, and it may be that the reader will gain the impression that some overlapping has taken place. It is, for instance, suggested here that the Personnel Department should keep a record of rates of pay and increases and should supervise the application and negotiation of wage agreements. In other places in this book these matters are considered to be the duty of the Wages Office and the Planning Department. This need not be a contradiction. Information obtained by one department is often needed by others and it is only necessary to decide which department is to do the detail work and send on the results to other interested departments. The main work of the Personnel Department is to foster and improve co-operation between all departments and how it is fitted into the organization as a whole will depend on many factors that will vary from firm to firm. The author would impress upon the reader again that in organization there are no fixed rules which can be learnt and applied in all circumstances, and that it depends entirely on the opinion of the managing director which method he chooses as right and best for the concern for which he is responsible.

Finally it may be emphasized that only the "giants of industry," the very large concerns, would be justified in developing a Personnel Management Department on the scale of the scheme described at the end of this chapter.

Industrial welfare, personnel management, or labour management—by whatever title it is called—performs an essential function in every industrial organization, and upon its proper performance depends to a large degree the prosperity of the business and all employed in it.

In every business concern, however small, workers must be engaged, trained, transferred, promoted, and, if necessary, dismissed. They must be employed in conditions which comply with the Factories Acts. In many factories, moreover, first-aid rooms, and welfare departments are already statutory requirements. These are but the bare essentials; many firms have gone far beyond them in the development of their personnel policy. The point for emphasis is that in *all* organizations employing workpeople these essentials have to be handled somehow by someone.

In very small concerns a director or works manager may personally undertake the work involved; in larger works this should be delegated to a specially appointed officer. But the head of the business must always take the ultimate responsibility for policy. If he delegates the personnel functions to a special officer, he must see to it that the officer's position fits harmoniously into the organization as a whole. For this two things are essential: first, that personnel policy should be clearly formulated and made known throughout the company; second, that the responsibilities of the personnel manager should be made clear to all the other executives and to the workers' representatives. Too often an officer is appointed and told that the job will be what he makes it, and he is left with the difficult task of explaining to foremen and others that he is not interfering with their responsibilities or undermining their authority. In no other executive appointment is a newcomer expected to take up his duties with such a tremendous handicap. Elasticity is certainly advisable if personnel work is to expand and develop, but it can only be built on a sure foundation with the sympathetic co-operation of other executives. It cannot be too clearly emphasized that although the personnel officer is responsible for carrying out the personnel functions, he can only succeed in so far as the firm's personnel policy permeates *all* the activities of the business, and influences everyone engaged in it from the managing director to the youngest worker.

Industry in Great Britain shows such variety in location, kind, tradition and size, that it is difficult to lay down a standard for the organization of personnel work which is equally applicable in every instance. It may be said, however, that the following are the five main functions which should be centralized under the personnel manager.

1. Employment.
2. Education and Training.
3. Working Conditions.
4. Industrial Relations.
5. Employee Services.

Only in very small factories is it possible for an executive to combine these functions with other work. In factories of 250 and upwards it is desirable to appoint a qualified and experienced officer to undertake this work, and in larger factories an adequately staffed Personnel Department is necessary. Where a new appointment of this executive is made, the purpose of the new organization should be carefully explained beforehand to prevent friction and misunderstanding. Standing should be that of a senior executive, and the personnel manager should normally be directly responsible to the managing director.

Employment

The centralization of all machinery for recruitment and selection, personnel records, and transfers and promotions, is necessary to ensure that labour in the factory is maintained at the most efficient level and that all the workers are employed where their experience and capacities may best be used. Only thus will a stable working force be built up. To undertake this work the personnel officer must possess intimate knowledge of the labour needs of different departments in the factory, of the nature of the processes, and of conditions governing wages and hours, and he must work closely with the heads of departments. He must be familiar with the legal provisions relating to employment, national health services, and with trade union and other agreements covering different categories of workers in the factory.

The employment function involves—

1. Contact with the works manager, departmental manager, or foremen to ascertain the numbers of full- or part-time workers needed, the types of skill demanded, the conditions of work, hours, wages, shifts, the probable duration of employment, and prospects of promotion or transfer. Preparation of requisition and job specification forms.
2. Contact with foremen or departmental managers to ascertain whether any department has workers who could suitably be transferred to vacancies in other departments.
3. Contact with Ministry of Labour, Juvenile Employment Committee, and other appropriate authorities.
4. Interviewing applicants, selection and allocation to jobs. Arrangements for medical examination and selection tests.
5. Preparing written conditions of service.
6. Reception and initiation of new employees; instruction in safety rules; arrangement for education and training; introduction to the works.

7. Arrangements for transfers, upgrading and promotion, and wage increases.

8. Interviewing employees on leaving. Dismissals.

9. Maintaining employee records and register of applicants.

Experience in the services during the war has confirmed the value of selection tests as part of the selection procedure, but the introduction of suitable tests requires expert guidance. Moreover, it should be emphasized that tests in no way take the place of the interview, but, combined with the interview, give a much fairer assessment of an individual's capabilities.

The medical examination of all new entrants should form the basis of any industrial health service and, if possible, follow-up examinations should be arranged.

Since the interview of applicants is their first introduction to the factory, this should be as friendly and informal as possible, and the prospective employee should be fully informed about conditions of work and future possibilities.

Education and Training

The lack of proper introduction to work is often a cause of labour wastage, especially among juveniles. Experience has shown that the greatest labour turnover is in the first six months of work. Where there is a special training or initiation scheme in operation, introduction to the factory and to the job is part of the training programme, but where there is no such scheme, the personnel officer should see that the new employee is given a proper introduction to the works and his fellow workers and adequate instruction on the job. The training of foremen in the best method of job instruction has only recently received the attention it deserves.

The main responsibilities of the personnel officer in the introduction and training of new employees are—

1. Personal instruction on factory conditions and employee services. A works handbook provides an excellent medium for giving information on works rules, canteen, first-aid room, health services, rest room, lavatories and cloakrooms, fire and safety regulations, transport services to and from work, works funds, clubs, etc.

2. Guidance on personal adjustment to factory work, especially on the maintenance of good health and of good relationship with fellow employees, and the avoidance of accidents. Safety instructions should form an essential part of any initiation or training scheme.

3. The establishment of an initiation or training school, or the

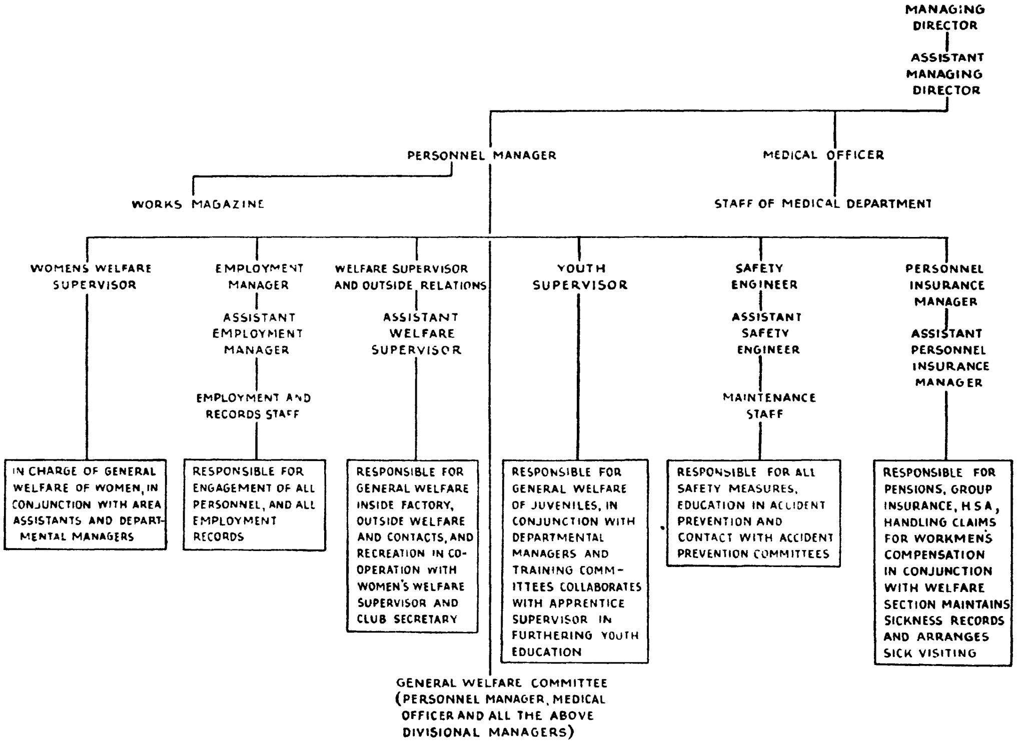
MANAGING DIRECTOR
ASSISTANT MANAGING DIRECTOR
PERSONNEL MANAGER
MEDICAL OFFICER
WORKS MAGAZINE
STAFF OF MEDICAL DEPARTMENT
WOMENS WELFARE SUPERVISOR
EMPLOYMENT MANAGER
ASSISTANT EMPLOYMENT MANAGER
EMPLOYMENT AND RECORDS STAFF
WELFARE SUPERVISOR AND OUTSIDE RELATIONS
ASSISTANT WELFARE SUPERVISOR
YOUTH SUPERVISOR
SAFETY ENGINEER
ASSISTANT SAFETY ENGINEER
MAINTENANCE STAFF
PERSONNEL INSURANCE MANAGER
ASSISTANT PERSONNEL INSURANCE MANAGER
IN CHARGE OF GENERAL WELFARE OF WOMEN, IN CONJUNCTION WITH AREA ASSISTANTS AND DEPARTMENTAL MANAGERS
RESPONSIBLE FOR ENGAGEMENT OF ALL PERSONNEL, AND ALL EMPLOYMENT RECORDS
RESPONSIBLE FOR GENERAL WELFARE INSIDE FACTORY, OUTSIDE WELFARE AND CONTACTS, AND RECREATION IN CO-OPERATION WITH WOMEN'S WELFARE SUPERVISOR AND CLUB SECRETARY
RESPONSIBLE FOR GENERAL WELFARE OF JUVENILES, IN CONJUNCTION WITH DEPARTMENTAL MANAGERS AND TRAINING COMMITTEES COLLABORATES WITH APPRENTICE SUPERVISOR IN FURTHERING YOUTH EDUCATION
RESPONSIBLE FOR ALL SAFETY MEASURES, EDUCATION IN ACCIDENT PREVENTION AND CONTACT WITH ACCIDENT PREVENTION COMMITTEES
RESPONSIBLE FOR PENSIONS, GROUP INSURANCE, H S A, HANDLING CLAIMS FOR WORKMENS COMPENSATION IN CONJUNCTION WITH WELFARE SECTION MAINTAINS SICKNESS RECORDS AND ARRANGES SICK VISITING
GENERAL WELFARE COMMITTEE (PERSONNEL MANAGER, MEDICAL OFFICER AND ALL THE ABOVE DIVISIONAL MANAGERS)

FIG. 19. EXAMPLE OF THE ORGANIZATION OF A PERSONNEL MANAGEMENT DEPARTMENT IN A FIRM OF ENGINEERS EMPLOYING 12,000 WORKERS

allocation of a special section of the works to training. This provides not only an opportunity for gradual mental and physical adjustment to factory life, but ensures correct methods of working, thus eliminating much spoilt work and low efficiency.

4. Information to the employees on the firm's products, and on how the individual's work fits into the stream of production. Arranging visits to other departments and special exhibitions of the firm's work.

5. Encouragement of wider education through lectures, classes and discussions. Arrangements, where possible, for continued education for juveniles.

6. Establishment of a works magazine or bulletin.

Accurate records are essential for the efficient running of a personnel office, but their number should be kept down to the minimum and duplication should be avoided wherever possible by centralizing them in one place. The criterion of efficient records is that information can be quickly extracted from them and analyses made. The following are briefly the records which are essential—

1. *Application Form* containing all the preliminary information required about a new entrant, e.g. personal details, experience, references, interviewer's remarks, notes on starting date, job, rate, etc.

2. *Reference Index* containing as much permanent information as possible for easy reference, e.g. name, number, address, age, married or single; notes on call-up; address of next-of-kin; date of engagement and leaving; name of panel doctor, etc. Grouping this information makes for easy reference. The best system for quick reference is the flat, visible card index, which allows important items to be signalled along the visible edge.

3. *Master Record* consisting of folder or envelope in which all papers relating to the individual employee can be placed. Progress records, lost-time records, application forms, etc., can be kept in this folder, if desired.

4. *Progress Record* giving details of transfers, promotion, wage increases, classes taken, etc. This can form the reverse of the individual record card, or can be kept separately in the master record folder.

5. *Absenteeism Card* recording details of lateness and absence, together with reasons.

Where there is a works medical service, separate health records must be kept, and the first-aid room must always keep a record of attendances and treatment, and a register of accident cases.

Both health and absence records should be analysed periodically for any tendencies which should be investigated and checked, such as excessive incidence of sickness in one particular department. Similarly, an analysis should be made of labour turnover, and for this purpose careful records should be kept of those leaving and the reasons, whether avoidable or unavoidable. An *In and Out Book* for daily record of entrants and leavers enables the Personnel Department to have readily available figures relating to the labour force.

In addition to individual employee records, there are certain regular forms for internal communication which need to be standardized, such as—

1. Requisition forms for labour from foremen or departmental heads to inform the Personnel Department in advance of what labour is required.
2. Starting and termination notes to be circulated to the various officials concerned.
3. Notes of transfer, promotion and pay increases to be circulated to the various officials concerned.
4. Notification of absentees to be circulated to the various officials concerned.
5. Passes-out to be signed by foreman, medical officer, nurse, or personnel manager.

Reports. It is extremely valuable if a periodic report on all welfare and personnel matters is placed before the managing director. This should remain a brief analysis of statistics relating to labour turnover, health and timekeeping; notes on activities, general tendencies and projected developments. This report, or something on similar lines, may very usefully be circulated to all executives to keep them informed on personnel policy. Similar reports might be submitted to the works council or committee.

Working Conditions

It was estimated before the war that 29 million weeks were lost to industry each year in England and Wales through sickness qualifying for National Health Insurance benefit, and the average annual loss was reckoned as ten days for men and twelve for women. In addition there is a large group of those whose health is below standard and whose efficiency suffers in consequence. This is not only a great source of waste, but places a heavy burden of suffering on thousands of those employed in industry. It is the responsibility of the personnel officer to do everything possible to cut down sickness and accidents in the factory and to build up a healthy working community. But industry has not only to consider hygiene and the maintenance of health; it must also play its part in fitting the permanently disabled into suitable work and in assisting the temporarily incapacitated to recover full capacity.

The main steps which should be taken to maintain the health of the employees are—

1. Supervision of the physical working conditions of the factory: ventilation, temperature, humidity, lighting and colour, seating, cloakrooms, and lavatories. Checking compliance with the conditions of the Factories Act and other legislation.
2. Establishment of first-aid and rest rooms under qualified supervision. Close co-operation with the nurse and medical officer.
3. Keeping accurate records and analyses of all sickness absence, and attendances at the first-aid room, as a check on the causes of sickness.
4. Supervision of the quota of disabled persons employed in the factory.
5. Organization of canteen service and refreshments during rest pauses to ensure that adequate meals are available at reasonable prices for all employees, including shift workers.
6. Attention to mental and emotional reactions of individuals and groups, and to the type of supervision in the factory, all of which have an important bearing on health and fatigue.
7. Observation on the effect on health of hours and spells of work.
8. Securing the advice of technical experts, both medical and scientific, on possible hazards arising from the use of new processes or substances.
9. General health education and advice on personal hygiene.
10. Maintaining contact with sickness and accident cases to ensure adequate attention, and co-operation in schemes for rehabilitation after long sickness or accident.

The appointment of a full- or part-time works medical officer is desirable. Medical supervision is an important factor in reducing sickness and maintaining a high standard of health and hygiene in the factory. The staff of the first-aid room should be under the general direction of the medical officer, and he should work in the closest co-operation with the personnel staff. A doctor should always be on call for cases of sudden illness or accident where there is no full-time medical service, and contact should be maintained with local hospitals.

Accidents are a serious source of waste, yet the figures in the Annual Reports of the Chief Inspector of Factories show that over 80 per cent of factory accidents are due not to the use of power-driven machinery but to human carelessness and failure.

Well-organized safety schemes can very considerably reduce the incidence of accidents. In addition to maintaining health and good working conditions, and the careful selection and placing of workers, the following are the essentials of any accident-prevention scheme—

1. The appointment of a full- or part-time safety officer, to whom can be delegated much of the work outlined below.
2. Instruction of all new employees on safe working methods through personal talks, films, lectures, demonstrations, and pamphlets.
3. Careful and frequent inspection of the works to ensure that gangways are clear, passages adequately lighted, materials well stacked. Works tidiness and good housekeeping are basic in any safety programme.
4. Inspection, in consultation with technical staff, of machines and plant to secure that adequate guarding is provided, maintained and used, and to see that adequate lighting is provided, and colour used to denote danger points or to make certain parts of the machine stand out clearly.
5. Provision of overalls, special protective clothing, caps, goggles and respirators wherever these are necessary, and supervision to ensure that such equipment is properly used and maintained.
6. The election of an accident-prevention committee which should investigate every accident and dangerous incident, and advise on measures to prevent a recurrence.
7. Organization of accident-prevention campaigns by means of posters, films, competitions between departments, articles and notices in works magazines, etc.
8. Training of men and women in the works in first-aid and arrangements for refresher courses.
9. Ensuring that even the most trivial accidents are reported to the first-aid room and that the employees attend for re-dressings while they are at work.
10. Keeping full records of all accidents and treatment in the first-aid room. Analysing frequency and severity of accidents.

Industrial Relations

The achievement of a national policy of full employment depends largely on maintaining efficiency within the factory, for only by cutting out all wasteful methods can production be carried on at an economic cost. The maintenance of efficiency, in turn, depends upon the establishment of good relationship within the works, and this should be the principal aim of personnel policy. Without close co-operation between management and workers, measures to increase output, to improve working conditions, and to decrease accidents, labour turnover and sickness incidence are rendered ineffective. The factory is a social as well as a technical unit and depends on individuals and groups working together. Experience shows that good relationships cannot be created by a mere paper plan. The working out of the plan involves constant contact with groups and individuals, and sympathy and understanding are essential for its successful operation. Joint consultation is valueless unless the management give it their wholehearted support, and by their sincerity merit the confidence of the workpeople.

The appointment of a personnel manager does not in itself ensure good relationships. Personnel management is not a function which can be isolated in one department. It is part of any manager's duties and requires the active practice of all executive and supervisory staff. Managers, foremen and charge-hands, though technically proficient, must also be appreciative of human needs and difficulties, and it is most important that personnel policy should be explained to them in training courses, regular talks and discussions. Senior executives should meet periodically to discuss personnel policy, and should be encouraged to attend lectures and conferences on personnel questions, and to visit other works.

The following measures may prove helpful in promoting sound industrial relationships—

1. Active encouragement of all schemes for further education.
2. Maintenance by the personnel staff of close personal contact with individual employees as a means of overcoming the impersonal element in modern factory organization.
3. Setting up formal and informal consultative machinery, i.e. works councils, welfare committees, and joint production committees representative of employees and management.
4. Maintaining close contact with trade-union representatives in the factory.
5. Giving information to employees on the firm's policy, programme of work and emergency plans, through shop stewards, works committees, works magazine and bulletin boards, or by brief broadcast statements.
6. Assisting employees seeking advice on personal difficulties.
7. Organizing employee services such as music at work, sickness and benevolent funds, saving funds, recreational schemes, etc. All funds and clubs should be run through employee committees.
8. Planning anti-waste campaigns, accident-prevention drives, national savings schemes, collections for hospitals and charities.

The success of such plans depends on the active support and collaboration of workers' representatives.

9. Maintaining contact with employees in the Forces; reinstatement and retraining after service.

In all this work it should be remembered that it is the sum of small annoyances, the feeling of personal injustice or discomfort, which plays a large part in individual and group relationships. The strain and fatigue of modern industrial life tend to magnify minor difficulties in the minds of both employers and employed, and the task of dealing promptly and sympathetically with them on the spot assumes great importance.

Outside Welfare

The extent to which the personnel officer should deal with matters affecting employees outside factory hours depends largely on local circumstances. Certainly there should be no interference with the personal freedom of workers to do exactly as they please in their leisure time, but practical guidance and help may be required on such matters as—

1. Facilities for transport to and from work. This involves careful study of the places of residence and the means of transport available, co-operation with local transport committees, etc.

2. Housing problems. This involves co-operation with local authorities and voluntary agencies, who can often be more easily approached by a firm than by an individual.

3. Facilities for education outside working hours through local authority evening classes, voluntary organizations, and classes and lectures arranged by the firm.

4. Recreational and social facilities where local provision is not adequate and there is a spontaneous demand. In this, several factories may usefully co-operate. The help of local authorities, local youth committees and voluntary bodies should be sought, and, wherever possible, encouragement and support should be given to existing clubs instead of setting up new ones. The Central Council of Physical Recreation can assist by providing instructors for "keep fit" or physical training classes in factories. Concerts and entertainments may be organized in meal breaks and in works clubs, and encouragement given to hobbies and handicraft.

5. Help to employees in legal or financial difficulties by putting them in touch with available sources of assistance, e.g. Citizens' Advice Bureaux, Poor Man's Lawyer, and Soldiers', Sailors' and Airmen's Families Association.

6. Facilities for special medical, hospital, and convalescent treatment and rest breaks.

7. Help to employees and their families in case of hardship.

8. Assistance to employees in the services and to their families when they are in difficulty.

The closest co-operation should be maintained with Ministry of Labour officials and local health and education authorities.

CHAPTER XXIII

INDUSTRIAL LEGISLATION

IN this chapter is given a short survey of this subject, no more than an abstract from some of the special publications which are listed in Appendix III. Readers who are particularly interested should refer to them.

Company Law

Industrial companies are, according to the Companies Act, 1948, either limited by shares, limited by guarantee, or unlimited. Of these groups the first is so overwhelmingly in the majority that the others need not be considered here at all. The participant in this kind of company can only be made liable for debts incurred by the company up to the nominal value of his shares. This is in striking contrast to a partnership where there is no limit to the liability of a partner in respect of partnership debts. Another characteristic is the incorporation of the company, which has far-reaching legal consequences as it makes the company into a legal entity. Working capital can be obtained by the company by issuing a Prospectus and finding subscribers who become shareholders, i.e. members, or by issuing debentures and securing holders who thereby become creditors.

Companies can be formed either to acquire and carry on an existing business or undertaking, or to start some new business or undertaking. After a preliminary agreement between the persons concerned the next step is to execute the Memorandum of Association and the Articles of Association of the company. The former must state: (1) the name of the company with "Limited" as the last word, a condition which can be dispensed with only in exceptional circumstances; (2) whether the registered office of the company is to be in England or Scotland (Wales considered as being part of England for this purpose); (3) the objects of the company; (4) that the liability of the members is limited; (5) the amount of the share capital and how it is to be divided into shares. The shares may be divided into different classes, e.g. preference, ordinary and founders; special rights may be attached to each class.

The Articles of Association will contain, among other things, regulations about the transfer of shares; general meetings of shareholders; appointment, powers and duties of the directors; accounts;

dividends; voting rights, etc. If so desired, the model set of Articles, known as Table A and found as a schedule to the Companies Act, 1948, may be adopted by a public company. While the alteration of the Memorandum is subjected to very strict legal restrictions, the Articles are much more flexible. Both documents must be taken and delivered to the Registrar of Companies at Bush House, London, W.C. 2, whereupon, subject to certain legal formalities, a Certificate of Incorporation is issued. While a private company can then go to allotment immediately and begin business, a public company can do so only after some further formalities.

The promoters of a company are those who form the company and set it going. They are regarded as trustees for the company and they are not allowed to make any secret profit out of or in relation to the company, but in many cases it is quite just that they should be reasonably remunerated for their services; this remuneration, however, must be disclosed in the Prospectus.

A Prospectus is an invitation to the public to provide capital by subscribing for shares or debentures, and such an invitation without a Prospectus is illegal; it has to give details about the position and prospects of the company, "telling the truth, the whole truth and nothing but the truth." There are various conditions to be fulfilled when issuing a Prospectus and no prudent man should consider becoming a shareholder in a company unless he is satisfied that the Prospectus complies with the law.

To obtain capital a company usually finds it necessary to pay commission to the person who procures such capital. This payment is quite legal, but only if it is made subject to certain conditions laid down in the law.

When shares are offered to the public for subscription it is usual to make certain of obtaining the necessary capital by having the issue "underwritten." This is to-day very much a matter of course and regarded as an insurance against risk. The rates of commission vary according to the character and prospects of the company—5, 7 and, as maximum, 10 per cent are not uncommon.

Every company must keep in one or more books a register of its members or shareholders—the two terms being synonymous—containing the names, addresses and occupations of the members; a statement of the shares held by each member and of the amount paid or agreed to be considered as paid on the shares of each member; the date at which each person was entered in the register as a member; and the date at which any person ceased to be a member.

If the company needs to increase its capital, it must do so by a resolution passed at a general meeting of the members. The new shares may rank equally with the old ones for dividends; but sometimes when further capital is required, it is necessary to give the new shares a preferential dividend in order to induce persons to subscribe. The privilege given to preference shareholders varies considerably according to the circumstances in which the shares are issued.

A company may, by resolution, convert any of its shares into stock, if the Articles provide for such a conversion. Reduction of capital of a company is a more complicated procedure, but this is not the right place to go further into these details.

Companies are in general managed by directors who are elected by the shareholders in accordance with the rules contained in the Articles of Association. They usually retire annually in rotation but are generally eligible for re-election. A director is bound to carry out his duties according to the law with such care as is reasonably to be expected from a person of his knowledge and experience and if he fails to exercise that care he is liable in damages for negligence. The Articles generally require that a director shall hold a certain number of shares in the company. The Articles also determine the powers of the board of directors in detail, they fix the mode in which they exercise them, how their meetings should be carried out, etc. Their duty is to determine and fix the overall policy of the company and to appoint managers, secretaries and other subordinate officers for the execution of this policy. In addition the Articles usually empower the directors to appoint one of their body to the office of managing director for such a term and such a remuneration as they think fit. He can be simultaneously the chairman of the board of directors and is not infrequently so, but this ought not to be the case. It is a well-settled custom that the board of directors do not interfere with the day-to-day business of the company, but leave this to the management, asking only for such statistics and other fundamental data as to enable them to make certain that the policy they have initiated is actually being executed.

In order to understand the legal foundation of an industrial concern it is necessary to know something of the duties of the secretary and of his peculiar position. Every incorporated company must have its secretary. The Articles sometimes contain a clause declaring who shall be the first secretary. In any case a resolution will be passed appointing a secretary and stating his remuneration and, if the terms of his appointment are special, the agreement with the secretary should be put into writing and signed by him and by some person authorized by the board to sign on behalf of the company. The duties of the secretary will depend on the size and nature of the company, and of the arrangement made with him. But in any case he will be present at all meetings of the company and of the board of directors, and will take proper minutes of the proceedings; he will issue under the direction of the board all notices to members and others that may be requisite; he will conduct all correspondence with shareholders and will keep the books of the company, or such of them as relate to the internal business thereof, e.g. the register of members, the share ledger, the register of mortgages, etc. He will also make all necessary returns to the Registrar of Companies. Sometimes one of the directors discharges gratis the functions of a secretary and occasionally the offices of the secretary and one of the managers, e.g. the personnel manager, are amalgamated, especially in medium-sized and small companies.

The secretary should have a knowledge of the law relating to companies and of any other laws which may in any way affect the operation of the company of which he is secretary, and he should of course be completely familiar with its Articles. He is liable to heavy punishment or penalties for any offence committed by or on behalf of the company against these laws or regulations, as for instance falsifying any books or documents of the company, or if he is knowingly a party to failing to register charges created by the company, or failing to make the Annual Return, etc. His name and address must be included in the Annual Return to the Registrar. As may be seen from these few remarks, his position is unique among the executives of the company in so far as he is certainly subordinate to the general management, as are all other executives, but at the same time he must control the management to stop them taking any step which could bring the company into conflict with the law.

Every company must, by law, keep proper books of account in respect of—

(*a*) All money received and expended by the company and the matters in respect of which the receipts and expenditure take place;

(*b*) All sales and purchases of goods;

(*c*) The assets and liabilities of the company.

Proper books are deemed to be kept only if they contain the necessary details to give a true and fair view of the state of the company's affairs and to explain its transactions.

Not later than eighteen months after its incorporation and once in each calendar year thereafter the directors must lay before the Annual General Meeting of the shareholders a Profit and Loss Account and a Balance Sheet, attached to which must be a report of the directors with respect to—

(*a*) the state of the company's affairs;

(*b*) the amount they recommend as dividend; and (*c*) the amount they propose to carry to reserves.

The Balance Sheet must be signed by two directors and have the auditor's report attached to it. Copies must be sent to all shareholders having the right to attend general meetings not less than twenty-one days before the date of the meeting.

Every company is obliged to have an auditor who is appointed at the Annual General Meeting and holds office until the next Annual General Meeting. The auditors must make a report to the members on the accounts examined by them and, as already mentioned, on every Balance Sheet laid before the company during their tenure of office and the report must state—

(*a*) whether or not they have obtained all the information and explanations they have required for the purposes of their audit; and

(*b*) if in their opinion proper books of account have been kept.

They must also report if they have examined the Balance Sheet and Profit and Loss Account and if these are in agreement with the books of account, and if in their opinion the Balance Sheet gives a true and fair view of the state of the company's affairs and the Profit and Loss Account a true and fair view of the profit and loss for the financial year. The auditors perform this duty by forwarding their report to the secretary.

Factory Law

Legislation on this subject was initiated at the beginning of the nineteenth century and the law as it then stood was consolidated in the Factories Act, 1937, which has proved so successful that it remains to-day substantially unchanged. Only one amendment, in 1948, which does not alter anything essential of the original text, has been thought to be necessary. This fact certainly shows that a first-class legislative job has been done in the Act, especially when it is remembered that since 1937 revolutionary changes have occurred in the structure of industry during the years which include the war and post-war periods. A very short summary of factory legislation is all that is possible in this book. Readers who wish to know more are referred to the publications indicated in Appendix III.

The Act refers not only to all places where articles are made, altered, repaired, ornamented, finished or adapted for sale, by way of trade or for purpose of gain, but also to places where articles are cleaned, washed, broken up or demolished. Thus it will be seen that "factory" has a wide definition. The extensive powers of the Home Secretary to make rules, regulations and orders for application of and exemptions from the Act in special cases are a vital part of it and give the law flexibility to meet varying and changing conditions. There is undoubtedly a certain amount of bureaucracy in the application of this Act, which may be a burden, especially to small- and medium-sized works; but everybody who understands the development of industry and the necessity of creating a spirit of co-operation of all concerned will agree that this cannot be avoided completely. It is the duty of the controlling authorities, especially the factory inspectors, to see that the Act is enforced not only with the necessary care and firmness, but also with the flexibility and the understanding of practical necessities which the well-being of industry requires. Here once more the human factor is of the greatest importance; it is not the letter of these regulations which is important, but the spirit which animates them.

It may be useful here to give a brief summary of the Act. For further details readers are again referred to the special publications a selection from which is given in Appendix III.

The Factories Act, 1937, is divided into fourteen parts, each of which comprises several sections.

Of these Part I deals with health (general provisions) under the headings: cleanliness, overcrowding, temperature, ventilation, lighting, drainage of floors, sanitary conveniences, and power to require medical supervision. Under these provisions accumulation of dirt and refuse must be removed daily and the floor of every workroom cleaned at least once a week. The production engineer is of course well aware that this requirement is a minimum and that he should see that the highest possible standards of cleanliness that circumstances permit are maintained, not only in the interest of the health of the workers, but also for the sake of the quality of their work. Unfortunately, the whitewashing of the walls of rooms, passages and stair-cases, also prescribed under this heading, is more often neglected, although it is necessary for the same reasons as the removal of dirt and refuse.

The overcrowding of workrooms is prevented by laying down a minimum of 400 cubic feet per person working in the room. A reasonable temperature for light sedentary work is considered to be 60°F. The factory inspector may demand corresponding temperatures for other kinds of work and enforce appropriate heating and ventilating appliances. The necessity for suitable workroom lighting has already been stressed as a necessity for accurate and uniform work, but bad lighting also has an adverse effect on the workers' health and increases the danger of accidents.

What the law has to say about sanitary conveniences is so generally accepted to-day that it hardly needs to be mentioned, but there is no doubt that at the time these regulations were first drawn up they contained revolutionary ideas for many firms, and even to-day all these seemingly obvious requirements are not everywhere put into practice: that there really are a sufficient number of conveniences, with good lighting, privacy, cleanliness, and proper drainage, with separate accommodation for each sex, etc. It is one of the duties of the maintenance engineer, sometimes considered with aversion, but nevertheless of considerable importance, to see that these arrangements are maintained at their original standard, that they are kept clean and not considered as smoking cabinets in works where the type of production forbids smoking in the workshops.

Medical supervision, the final subject dealt with in Part I of the Act, is of purely preventive character.[1] In addition to supervising the arrangements for first-aid treatment in the case of accidents, it should do what is humanly possible to prevent any outbreak of an infectious disease and to prevent and reduce the incidence of occupational diseases such as silicosis or asbestosis originating from the kind of work being done.

Part II of the Act is headed "Safety"; it deals with the protection of the workers from dangerous machinery, noxious gases, and fire. The production engineer will get help in this field from the factory inspectors, from the engineering firms supplying the machine tools and from the fire insurance companies. Of the Sections 12 to 40, forming this part of the Act, 12 deals with prime movers, 13 with transmission machinery, and 15 with provisions as to the approach of unfenced machinery; 16 explains the requirements on construction and maintenance of fencing, etc. Safety in the use of hoists is the purpose of Section 22; 23 refers to chains, ropes and lifting tackle, 24 to cranes; 25 and 26 deal with the protection of the workers from the danger of falls. Floors, steps, stairs, passages and gangways are here the danger points. Staircases must have hand rails, openings in floors be fenced, ladders soundly constructed and properly maintained. Section 29 is devoted to steam boilers; 34 to 37 refer to means of escape in the case of fire. Finally, and most important, there are the requirements that the attention of all and especially of the young and inexperienced must be drawn to any dangers which may arise in the course of their work; that they should be instructed and supervised in the use of protective clothing and shields—caps to cover women's hair, goggles when working on grinding wheels, and the like; for it is a fact that while perhaps 23 per cent of all accidents, especially to young persons, cannot be blamed on anyone, of the remaining 77 per cent only about 30 per cent are due to causes within the employer's control, while the workers themselves are held responsible for the remaining accidents —nearly half of all accidents from all causes. Although statistics may show that expressed as a percentage the trend of factory accidents is slightly decreasing in number as well as in severity, the accuracy of the following quotation[1] cannot be doubted and should impress upon all concerned the necessity of doing their best to improve the present situation: "With all that has been done on accident prevention the number of accidents remains far too high. Further investigation is needed into many aspects of the problem—accident proneness, the effect of noise, of fatigue, of boredom, of hustle, the many vagaries of the human factor. Employers, designers, manufacturers, inspectors, safety-first organizers, psychologists and the workers themselves—all have their part to play. The huge toll of accidents costs industry £30,000,000 a year. This takes no account of what the injured workpeople suffer in loss of income and spending power, not to mention what is by far the worst part of the picture, the pain, anxiety and shock which often leave their mark while life lasts."

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[1] See also the amendment to the Act by the Factories Act, 1948.

Part III of the Factories Act, Sections 41 to 46, covers such things as: supply of drinking water, washing facilities, clothing accommodation, facilities for sitting, first-aid, welfare regulations, i.e. again deals with subjects which are to-day more or less taken for granted. It is possible that in old factories conditions are still unsatisfactory in these matters, but it is hard to imagine that there are places where not enough clean drinking water is available, or that there are only inadequate and unsuitable washing facilities and these not kept clean. It is doubtful whether the demand for soap and clean towels is fulfilled everywhere. It may still be customary that each worker has to provide these things himself, and keeps them in his locker with his everyday and working clothes. This suggests—and this is only reasonable—that washing facilities and clothing accommodation for one or more workshops should be combined in one room, with a locker provided for each worker. Although much factory work can only be done standing, interruptions are always possible, and possibilities of sitting down and relaxing should be provided for these periods, just as chairs which assist the correct position of the body should be supplied for persons engaged in sedentary work, such as typing.

A first-aid box or cupboard must be kept readily accessible for every 150 persons employed and it should be in the charge of a responsible person trained in first-aid treatment. Early treatment of small injuries, which the worker himself may even be inclined to overlook, should never be neglected and every encouragement should be given to use the facilities provided.

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[1] See *Factory Law*, by C. D. Rockham, p. 48, 1947 reprint of 1938 edition.

Part IV deals with special provisions and regulations for health, safety and welfare of workers in dangerous trades, and Part V gives information on the notification and investigation of accidents and industrial diseases. These two Parts are divided into Sections 47 to 59 and 60 to 69 respectively. The contents may be indicated by the following examples: removal of injurious or offensive dust or fumes; no meals to be allowed in workshops where poisonous substances such as lead, arsenic, etc., are used; regulations to extend in cotton mills the use of shuttles which are not capable of being threaded by the mouth, in order to abolish the unhealthy process known as "kissing the shuttle"; prohibiting the use of white phosphorus in making matches; limitation of artificial humidity in textile works; limitation of the weight to be lifted by any person or class of persons, especially youths and girls, in any factory or any process.

Twelve industrial diseases are notifiable, including lead poisoning and anthrax, toxic jaundice, and ulcerations of various kinds. The duty of notification to the Chief Inspector of Factories rests not only on the medical practitioner who attends a patient suffering from any of these twelve diseases, but also on the management of the factory.

The employment in industry of women and young persons under eighteen is treated in Sections 70 to 98, forming Part VI of the Act: "It is in some way the most important in factory legislation. It has occupied more time in Parliament than any other and provoked more controversy. There are more prosecutions every year for illegal employment than for any other contravention of the law; complaints on this are numerous as compared with almost every other subject and the proposals in the recent bill on hours of employment aroused more public interest than did the whole of the remaining sections. There is more than one reason for this. It is partly that hours of employment are of vital personal interest to every worker, controlling not only the time spent in the factory but also the hours that remain for rest, sleep, meals, sport, family life, and all the other claims on the leisure and interest of a human being. Another reason is that on the question of hours a Factories Act was particularly long overdue."[1] No useful purpose would be served by going into the details of these sections of the Act, as in the majority of industries of special interest to the readers of this book the hours of work are regulated by agreements between trade unions and employers' federations drawn up to comply with, and almost invariably improving on, the hours of labour specified in the Act.

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[1] See *Factory Law*, by C. D. Rockham, pp. 72–73.

In Sections 99 and 100 provisions are made for the issue of certificates of fitness for employment of young persons. The sections apply to all factories but exceptions can be granted by the Home Secretary in any class of factory where mechanical power is not used. The physician examining the boy or the girl has fairly large powers of discretion and many give a certificate that really reflects the state of health of the applicant. He can also limit the certificate temporarily if he thinks it advisable; he can revise it or revoke it, if he thinks that conditions or the state of health of the young person have changed. The cost of the examination is borne by the employer.

Part VII is a collection of various problems of different character. It deals with special applications and extensions: premises in respect of which the owner is liable: electrical power stations; charitable and reformatory institutions; docks, wharves, quays, warehouses, and ships; building operations; engineering construction works; and lead processes outside factories. The requirements of these Sections 101 to 109 are of little importance for the normal industrial enterprise, but they are mentioned here to indicate the comprehensive nature of the Act. The same can be said about Part VIII (Sections 110 and 111) which covers work done in the workers' home, an interesting item in itself, but outside the scope of this book.

Part IX consists only of Section 112, with the very promising heading "Particulars of Piece Work and Wages." It only provides, however, that the employer who pays his worker by the piece should enable him " . . . to compute the total amount of wages payable to him in respect of his work, furnish the particulars of the rate of wages and also the particulars of the work to which that rate applies in writing at the time the work is given out, and also exhibit these on a placard not containing any other matter and posted in a position where it is easily read." Although the requirement was originally intended for textile works only, the Home Secretary is entitled to apply Section 112 by regulation to any other class of factory.

Part X covers a very wide field under the insignificant title "Miscellaneous." It deals with the notification that must be made to the Inspector of the district, when it is intended to use premises as a factory. It specifies which abstracts from the Act have to be posted at the factory gate, how the various registers giving particulars of the young persons employed, of any accidents that may occur or industrial diseases, etc., have to be kept and made available for inspection by the proper authorities, and the returns of persons employed and some particulars of special groups of these persons that have to be made. Finally Part X devotes a short section to the duties of the persons employed, another section to the prohibition of deductions from wages save as otherwise expressly provided under the Factories Act, such as contributions for additional special benefits in relation to welfare regulations, and provisions with regard to weights, measures and weighing and measuring instruments used in ascertaining wages.

Part XI lays down under the heading "Administration," the main regulations for enforcing the Act. It sets up an authority which is in general a part of the Factory Department of the Ministry of Labour and operates through officials, generally known as Factory Inspectors—not to be confounded with the inspectors appointed by the factory management whose functions are described in a later section. The contents of this part XI may be best characterized by repeating the headings of the main sections: appointment and duties of inspectors, clerks and servants; powers of inspectors, especially to conduct proceedings before magistrates; certificates, duties and fees of examining surgeons; provision as to county and district councils, as well as to regulations and orders of the Secretary of State.

The remaining parts of the Act are of no great importance for the readers of this book. Part XII enumerates under the main title "Supplementary" a number of sections referring to offences, penalties and legal proceedings; Part XIII repeats that the Act should be applied to all factories as defined in the Act and explained above as far as its main features are concerned, and points out in a special section how far this also refers to factories belonging to the Crown; and lastly Part XIV is devoted to some interpretations, especially of the expression "Factory," and concludes with a number of general remarks.

In comparison with this great legislative work, the Factories Act, 1937, other laws concerned with factory life are of less importance and may be omitted in this survey. It is necessary to mention only the Truck Acts, the general effect of which can be summed up in a single sentence: Workers' wages must be paid in cash and not in kind. Simple as this principle seems, there are difficulties in interpretation and application which make it advisable to obtain an expert's opinion in all doubtful cases.

Trade Unions and Employers' Federations

It is difficult to add any general remarks about trade unions and employers' federations that cannot be inferred from the contents of this book or learned from the books enumerated in Appendix III, but there are a few points worth mentioning here.

It is often forgotten that a struggle of more than 125 years took place in England before the present state of mutual acknowledgment was attained. The modern attitude of union leadership is probably best expressed in the objects of the Amalgamated Engineering Union as laid down in the rules operative on and from 1st January, 1946—

> The control of industry in the interests of the community.
>
> The organization of all workers qualified for membership, the development of the most cordial relations with other unions in the industry with a view to the bringing into engineering, shipbuilding and kindred trades, and the obtaining and maintaining of just and proper hours of work, rates of wages, and conditions of labour.
>
> The negotiation and settlement of differences and disputes between the members of the union and employers by collective bargaining and agreement, withdrawal of labour or otherwise.
>
> Generally to promote the welfare of the members of the union.

What has made understanding between the two sides of industry so difficult in the past and does so sometimes still, is that these negotiations, disputes and discussions are so mixed up with politics that it is often almost impossible for the participants to keep their arguments on a purely economic or social basis. The confusion also makes so much of the literature on this subject almost valueless for anyone in need of a balanced point of view in order to be able to form his own opinion. The authors given in Appendix III, Tillyard and M. Turner-Samuels, have been selected with special care for their impartiality. The fact that the second of these two books is written by a Socialist M.P. has not lessened its objectivity, as the editor of the "Living in Britain" series of books, to which it belongs, correctly points out.

With this warning the subject could be left to the reader to study in publications or, better still, from actual experience, but one further point must be mentioned because of its great and growing importance which will cause it to claim increasing attention in the future. Anybody who pursues a detailed study of these organizations of employees with their widely-spread divisions and districts, committees, councils, and offices, will be astonished and probably also filled with admiration at what has been achieved in building them up in a comparatively short time from what were in many cases small beginnings. He will naturally be aware that such an enormous structure with a whole hierarchy of officers and officials from the president down to the shop stewards must be expensive to maintain, and he will ask himself, especially as there is a similar if smaller organization on the side of the employers: Does it pay? The answer is: If it guarantees peace in industry and leads to real co-operation between workers and management, it certainly does pay. For this purpose, however, it is absolutely necessary that the closest contact should exist between those who guide and govern trade unions and employers' federations and those who do the work in shops and offices. Without this close contact the understanding of the real working conditions is only too easily lost; under modern conditions changes are often so rapid and fundamental that the experience of, say, five or ten years ago may help to obtain, but will not give, the necessary knowledge of all that is going on inside a works. Moreover, it seems to be an unavoidable peculiarity of all human organizations—whether they are religious, government departments, trade unions, industrial undertakings, co-operative societies, etc.—that as they grow, the bureaucratic barriers which hinder and prevent close and friendly relations between the people working in them grow also, and very soon real co-operation almost ceases to exist. It is the particular responsibility of all who find themselves in positions of leadership or authority to keep an attentive eye constantly on this point and to interfere in time, before bureaucracy has developed and wasted the benefits that the organization was set up to obtain.

CHAPTER XXIV

INSPECTION

THE function "Inspection" has been often mentioned before in the course of these discussions, and it is unavoidable that some general remarks, which have been already made when dealing with other functions, should be repeated. To refer back to these remarks is not sufficient as the effect of a different point of view is to increase the importance of some considerations and to decrease that of others.

What Inspection Implies

In Alford's *Cost and Production Handbook*, inspection is defined as "the art of applying tests by and of measuring appliances to observe whether a given item of production is within the specified limit of variability." Although this definition seems very narrow when considering the vast subject of inspection in industrial works, some further restrictions are made in the original that have been omitted in this quotation. The use of the following definition is therefore preferred: "Inspection means the comparison of a condition, a quantity, a dimension, an effect and the like, as it is, *with what ought to be*. It consists, in short, in comparing the actual with the ideal. As, however, the ideal is never attainable—for otherwise it would not be an ideal—its meaning should be restricted to what is possible in practice, and it should be replaced by the expression the practical ideal, which may be understood to be a reasonable compromise between the various technical, economic and psychological considerations of the case in question."

This practical ideal is often termed "a standard"; but there is a danger of confusion in adopting this term of which everyone who uses it should be continuously aware. For inspection covers the whole range from comparison with universally fixed standards of measurement such as weights, dimensions, temperatures, electrical resistance, tensile strength, hardness, etc.—i.e. all forms of absolute measurement—to that type of inspection, no less real because based upon subjective or instinctive judgments, such as wine and tea tasting, the use of the thumb in testing certain types of cheese, and the eye of the furnace manager to judge the "luminosity" of a flame. In other words the term "standard" should in this connexion be given a wider interpretation than is usually put upon it by the engineer or as it is used in the title "British Standards Institution." It should also include those workpieces, methods, processes, instructions, etc., which are developed as guides by every works for their own use and are usually called "works standards." This consideration puts inspection into a different and much more important position than was usually given to it only a comparatively short time ago, say, immediately after the First World War. It can now be considered as one of the four main functions of the technical side of an industrial works and can be put on a par with design, production planning and production proper. As a matter of fact it is logically only a part of the apparatus of control that embraces and permeates an industrial works. It is not sufficient to plan or to order that something should be done; it is equally important to check that what is planned is carried out, and that the result comes up to what was, or could be, expected. One kind of control has already been dealt with in connexion with production planning and it has been explained why this control, which could perhaps be termed "administrative control," is in practice nearly always so closely connected with production planning that the expression "production planning and control" is familiar throughout industry, and therefore this term has been used in this book. Another kind of control will be explained in the last Part of this book under the title "Economic Control," and as inspection is yet another kind of control it might be termed "technical control" although it should not be forgotten that, as with all such divisions, there is no hard and fast boundary and each may make an occasional excursion into a neighbouring domain.

Control of Inspection

These considerations have occasioned the suggestion that it would be logical and therefore preferable to develop a single department "control" which would contain the three kinds of control, technical, administrative, and economic. There is no question that this would be logical, but logic is of less importance than how it could be fitted into the rest of the organization of the works. By following this idea of an all-embracing control-department it would probably be found that suitable staff would not be available, as persons sufficiently experienced and trained in technical, administrative and economic questions are comparatively rare, and the solution to the difficulty would be to divide the department into three sub-departments, which is only to return to the same system which has been abandoned for reasons of logic. This problem has been discussed here at some length to give another example of how following up what seems to be a straightforward principle in matters of organization, cannot always be recommended. This should be kept in mind, particularly in regard to inspection, which might be thought simple and easy to organize.

Some principles for the organization of inspection may well be developed: the independence of inspection from production proper is one of the main demands which is put forward in a modern works. The reader of this book will readily give the reason for it, as it repeats the general principle, that nobody should be controlled by somebody virtually dependent on him, because otherwise control would only too easily become a farce. A deviation from this rule may, however, be necessary, when for example a second expert of equal skill to the producer is not at hand or his services are too costly, or the inspector's decisions, being unsupported by an objective standard, only cause disputes rather than improve quality, as for instance the quality of a surface finish where no measuring instrument could be used in practice for reasons of cost. The solution in these cases is the right economic and psychological treatment of the producers.

An interesting example emphasizing this last point may be mentioned which might have been used by some "organizers" merely as an excuse for increased mechanization and bureaucracy. In a large engineering works for internal combustion engines those men who were deemed to possess a sufficient measure of ability and responsibility were permitted to be the sole inspectors of their own work. This highly-prized honour had been awarded to about 500 out of a total of 6000 employees. In addition, the workers thus singled out were expected to draw the attention of the foremen to any errors in drawings or defects in the works that they had discovered, to report any mistakes which they themselves had made, and to keep their machines and tools in such a condition as to set a model to the shop as a whole.

At the other extreme, inspection is only a comparison by some method of exact measurement and is done by unskilled labour, usually female, or even by automatic machines as in the case of balls for ball-bearings, or some kinds of munitions.

Between these two extremes the whole scale of possible inspection methods can be applied and it is the responsible duty of the expert to select the right one for the particular case.

It is obvious from these explanations that an intimate knowledge of technique, and of what is required of the finished products, is needed to make a choice of inspection methods, and whilst it seems almost impossible to develop general principles of any use there are, nevertheless, some common-sense considerations, which are often neglected in practice—

(*a*) Inspection should intervene as early as possible; hence the great importance of the inspection of raw material, whether it comes from outside or from another part of the works where it appears as a finished product. For instance, if the melting shop of an iron and steel works delivers defective material to the rolling mills, these defects, such as pipes, cracks, blow-holes, etc., must be removed from the surface of the billet before rolling, and the more or less rough methods employed may themselves be the cause of new trouble. The defects are chipped out with pneumatic hammers and chisels, and unless done with great care this may easily cause new defects; besides it requires large gangs of men and is therefore expensive. Scrupulous inspection during and after the melting process will reduce the work in the chipping bay and will greatly improve the quality of the rolled material. In this sense reduction in the costs of chipping may be regarded as a measure of the efficiency of the melting shop inspection if, of course, all other working conditions can be taken as constant.

(*b*) Casually considered, the second principle of inspection seems to some extent contradictory to the first; but actually there is no conflict. It is essential that the work of inspection should never be more thorough, nor the methods more refined, than the job warrants. In any case, the inspector should know the qualities and properties which are expected from the finished goods, so that inspection can be adapted to suit. It is obviously nonsense to insist on the same close tolerances and thorough inspection for the parts of an alarm clock to be sold for £3 as would be reasonable for the parts of a high-precision pocket watch with a selling price of £30. The principle "just good enough" should always be observed in inspection as in production proper. There is a tendency, especially in technical circles, to increase unduly the margin of safety, which, of course, should always be observed in reasonable limits. This tendency is only too comprehensible if the great responsibility of, for example, the steel maker is kept in mind, who has to deliver material for vital parts of motor cars or aeroplanes; but the economic point of view ought not to be overlooked. It should not be forgotten that technical progress will certainly render every machine obsolete in the course of time. If inspection has been too strict and, in consequence, the machine has been made "too good," it will also be too costly, and its sale will be endangered. Also it will be in too good a state long after its expected "duration of life." and the user will be inclined to keep it instead of scrapping it and getting an up-to-date machine, with the result that eventually his capacity to compete will decrease.

(*c*) Select carefully the strategic points where inspection should take place; limit the number of these points to those really essential; make sure that where inspection is found to be necessary, it is really efficient in equipment, manning, and organization. One hundred per cent inspection cannot always be recommended as it is costly and may have in some cases detrimental effects from a psychological point of view. The worker whose work is examined too carefully may, according to his temperament, become either careless or nervous, so that the degree of inspection must be chosen to suit the job, which in itself determines the kind of worker who is doing it.

(*d*) It is especially the organization of inspection, or rather its over-organization which is so often at fault in practice. It is of course necessary to have some kind of clerical apparatus connected with inspection: the errors and defects found out must be recorded and reports made as a basis for statistics from which alone conclusions can be drawn. It is rare that it is required to know which one of a number of parts is wrong, but what is usually important is to know the proportion of wrong parts in the total production; but all this writing and what belongs to it should be kept to the irreducible minimum, for it nearly all has to be done by the inspector himself and he is not a clerk, but very often a skilled worker, whose capacity could be used more economically in actual inspecting. It is also often found that a mass of reports is not used because there is nobody in the office who has either the time or the interest to study them.

Turning now to the materials to be inspected, it is usual to divide them into three classes—raw material, work in progress, and finished or saleable goods. Works put materials into one or other class according to the work to be done on them, e.g. castings are finished goods to a foundry, but raw material to a machine shop. It should not be forgotten that all buildings, machinery and equipment used in the works should be regularly inspected. This problem has been dealt with under "maintenance," and it has been shown that systematic inspection is needed to establish a sound basis of maintenance. It should be added that the regular inspection of *gauges and measuring instruments* in general is of particular importance. The quality of production depends obviously to a large extent on their accuracy, which must be constantly checked, as their use in the workshop, in production as well as for inspection, leads unavoidably to wear and tear and therefore necessitates occasional repair or replacement. Without giving too much detail, it should be noted that for working with limit gauges of the "go" and "not go" type two complete sets are necessary, one set for the shops, the working gauges, the other for inspection, the inspection gauges usually allowing for a greater degree of inaccuracy, i.e. having a greater tolerance. To check each set of working and inspection gauges there must be two additional sets of test gauges or master gauges, which are usually kept for this purpose in the toolroom. Finally a set of main master or test gauges is required for checking the two sets of master gauges in the toolroom, or it may be preferred to let the toolroom gauges be tested by an outside official institution. Even if—as would be the case in an up-to-date works—the number of different diameters used in the goods produced is reduced as much as possible, it is clear that the gauges represent a fairly large amount of invested capital, especially if it is remembered that for nearly every diameter there is a set of female or gap gauges for parts having this diameter as an outside dimension, and a second set of male or plug gauges for holes having the same diameter as an inside dimension.

The care of these expensive items in production and inspection is a very responsible job and the organization needed to make sure that every gauge is tested at regular intervals is certainly not easy to build up. It is a matter which cannot be neglected, for there is no question that gauges wear in use and so alter size, sometimes quite quickly. The consequences of using an incorrect gauge make its use even worse than the omission of all inspection. These considerations are so obviously correct that it is difficult to see how any person in a responsible position can ignore them. Nevertheless a surprising number of factories can be found where no gauge is ever checked, once it has been issued to production or inspection. It may be added that all human beings play an important part in manipulating almost all instruments of inspection, and may in fact themselves be deemed among them. Therefore psychological considerations must enter largely into account when organizing or criticizing the activities of an Inspection Department. It is not possible to follow up these interesting problems here and readers must be referred to the special literature on the subject if they wish for further information,[1] but the importance as well as the intricacy of the problems which the organizer of a system of inspection has to tackle in practice should be quite clear.

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[1] See, for example, "Some Problems of Inspection," by Winifred Raphael, in *Occupational Psychology*, October, 1942, pp. 157 to 163.

In this connexion it is obvious that the selection and training of an inspection staff is closely connected with technical and psychological problems, and has to be done with special care. It is only natural that various efforts have been made with psychological and other tests to find some method by which the capabilities of the individual for inspection duties may be measured and these methods may be useful in some cases. It should be remembered, however, what a wide range of ability is included in the profession of inspection, from an almost mechanical handling of objects to highly skilled work that can be done only by an experienced specialist. These higher stages can best be filled by workers who have actually done the work themselves, and it is a good policy to emphasize that a change from actual production to inspection is a promotion, and must be considered as the appreciation of first-class workmanship and excellent character qualifications; of course this should also find its expression in the payment for the new job.

This leads to the much-discussed question of the kind of wages system to be preferred for inspectors. Remembering what has been said about this problem in general, it is not necessary to prove that the fixed hourly or weekly rate is nearly always the best method of remuneration. Experience has shown that in the great majority of practical cases any incentive in the wage system as contained in the piece-rate system and in a less intensive form in any bonus system, does ultimately harm the work of inspection, even if, at first, it seems to be a help. The moral effect of fixed rates on the inspector, if these rates are sufficiently above the average earnings of the ordinary worker, should not be overlooked; this applies especially to those inspectors who have been promoted to their jobs because of their valuable services in actual production.

These general remarks about inspection should, however, not be concluded without a warning that this valuable and, indeed, fundamentally necessary work must not be overdone. In addition to the bad moral effect of over-inspection on the workers, there is certainly a limit at which inspection ceases to be economical. It is very difficult, indeed, almost meaningless, to give figures which purport to show when this turning point is reached. Figures will be found in some publications in the form of percentages of inspection wages in comparison to direct wages in production, but as they depend on too many variable factors, each influenced differently by the special conditions of the works in question, they can give no useful general guidance. To mention only one particular usually left out of these figures, the amount of inspection will depend upon the type of labour employed. More inspection will be needed if casual labour is employed than if there is a labour force of regular workers with a small labour turnover. Then again a new product will call for very strict inspection until everyone concerned is familiar with its production, when inspection can be gradually reduced to the minimum necessary to ensure that quality and accuracy is maintained.

Raw Material

As previously mentioned, the inspection of raw materials needs the close co-operation of the Receiving Depot on the commercial side and the Inspection on the technical side of the undertaking. As these two departments are obviously under the control of two persons of comparatively high standing in the hierarchy of the works, but usually having completely different outlooks and spheres of activity, their subordinates also are nearly always persons of different training and mentality. It is often, therefore, very difficult to bring about this co-operation, and detailed instructions for the division of duties are necessary in order to avoid overlapping or misunderstanding.

Details of the kind of technical inspection to which the raw material should be subjected depend so much on the special conditions of the works in question that it is not possible to deal with them on this occasion. It should, however, be noted that it is not only the main raw material which should be inspected before acceptance, but also all auxiliary materials which are consumed during production, such as lubricants, cotton waste, pickling acids and other chemicals, wood wools and other packing materials, power transmission belts, etc. These and similar items are sometimes left entirely to the Purchasing Department and the Receiving Depot, who are guided mainly by the price, and it is forgotten that considerable savings are often possible by selecting material of a higher original cost but better quality.

An important question which often arises and to which there is no one correct answer is: Where should the inspection and acceptance of the raw material take place? At the customer's receiving depot, or at the dispatch department of the supplier? The second place is generally proposed in order to save the transport costs for material that proves unsuitable and must be rejected; but this advantage is counterbalanced, at least partly, by the additional costs to the customer of their inspector's travelling time, his salary whilst travelling, and his living expenses whilst in the supplier's locality. Only trustworthy employees of strong character can be selected for this job and they must be paid a salary sufficient to encourage them to resist those temptations which are almost certain to arise in the constant daily intercourse with the supplier's employees.

There are, of course, many cases where this kind of relationship has worked very well, where this co-operation between customer and supplier has even developed so far that it has been agreed that each firm should abide by the results of one inspection, usually the supplier's, but sometimes the customer's inspection is accepted. These are certainly exceptional cases as long as the two works concerned are completely separated units. However, even in these cases the working conditions and the responsible personalities may change and a check inspection is advisable from time to time. But if, as so often happens, supplier and customer decide to merge their interests and operate as a single concern, then one inspection only of all materials passing between them should be the rule. Unfortunately this obvious economy is often not made in practice. The two works have grown up as separate units before the amalgamation and each has its own system of dealing with incoming and outgoing goods. Tradition may be given as an excuse in these cases, but it cannot be accepted as a reasonable explanation for letting matters go on in this uneconomical way. Yet the author remembers such "double" inspection or testing of material taking place where material was only passed from one department, where it formed "finished goods," to another in the same works, where it was used as "raw material." This state of affairs is mentioned here because it is not as unusual as it ought to be, and it is a good illustration of the way in which a measure of organization—like the amalgamation of two works—may fail to be as successful economically as was expected.

To return to the normal case with supplier and customer as two separate units, there is still an important function which a well-managed technical inspection of raw material can and should perform. Until now this department has been considered only as the place where it is decided whether material should be accepted or rejected. But the experience which can be collected by and during this inspection, wedded to the observations made in the behaviour of the raw material during production and in use in the finished goods, can increase their quality and value very considerably. It depends more or less on the personality of the manager of the technical inspection whether he has the ability to use the opportunity given by his position for developing his department into something much more important than was originally intended.

Fig. 20 gives a general idea of what is meant. It shows one way in which technical inspection, especially as it concerns the acceptance of raw materials, can be integrated with the organization of the whole concern. It may be remarked in advance that working conditions in a fairly large works have been assumed, because it is easier to separate the various departments from each other; the reader will have no difficulty in working out a similar chart to show how it will fit into the organization of a smaller concern. It is, of course, assumed that there is a laboratory properly equipped for making the necessary acceptance tests, etc. It is a further vital supposition that the manager of the technical inspection and therefore the superintendent of the inspection laboratory is a trained scientist, usually a metallurgist if in an engineering concern, who has had considerable practical experience in applying the results of laboratory tests in the shops. This practical experience is most important as without it there will be little mutual understanding between laboratory and workshops and therefore real co-operation will be missing, in spite of goodwill on both sides.

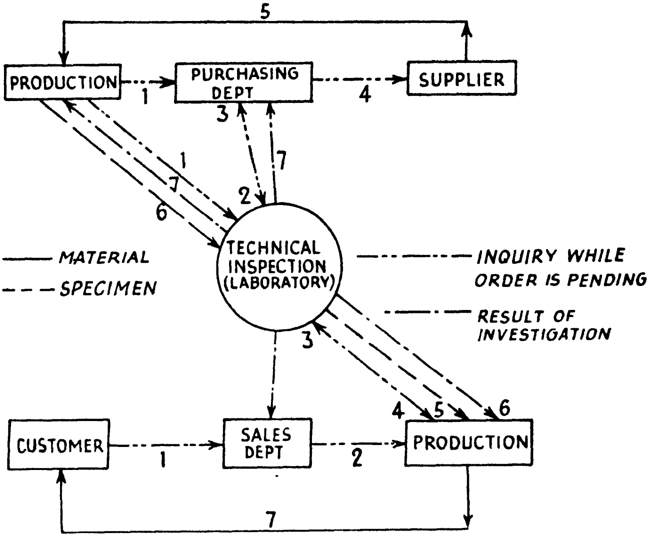

FIG. 20. THE TECHNICAL INSPECTION (LABORATORY), SHOWING POSITION IN THE ORGANIZATION OF A WORKS AND ESPECIALLY ITS CONNEXIONS WITH THE PURCHASING AND SALES DEPARTMENTS

To return to Fig. 20, there is, of course, no connexion between Fig. 20 and Fig. 12A, as they represent the position of technical inspection from two completely different points of view. Fig. 20 shows the technical inspection linked up with the organization of the whole concern, especially the Purchasing and Sales Departments. Added to the job of testing the incoming materials is the testing of the saleable goods, and especially action of an advisory nature to prevent the occurrence of mistakes. For instance, a Production Department needing a new kind of material for a job it has not done before, asks the laboratory for advice on the best material to obtain and how to make out the necessary specification (line 1). This specification with a requisition is sent to the Purchasing Department who can, if necessary, again confer with the laboratory (lines 2 and 3). The order is then sent to the supplier (line 4) who delivers the material (line 5), a specimen of which goes to the laboratory (line 6), which reports to the Production and Purchasing Departments (line 7). Production can now use the material with confidence that it is exactly what is required; or, if it is not exactly up to standard, they will know in what particular it fails. Similar connexions are also possible in the case of sales negotiations where the laboratory may help by giving advice on the firm's own products to the Production Department (lines 3 and 4) and where it tests specimens (line 5) to see if they fulfill customer's specifications, and reports to Production as well as to the Sales Department. It is obvious that an advisory activity of this kind is only possible if the Inspection has the necessary data for it; they are not at hand ready made, but must be obtained by collecting figures and facts from all available sources, standards, publications of various kinds, etc., but especially from experiments in the laboratory as well as in the workshops. The last give usually the best results as it is easier to verify whether the working conditions to which the data are to be applied coincide with those under which the data were obtained. Again it must be pointed out that a fairly extensive clerical apparatus with reports, card indexes, etc., is required, which has not only to be developed, but also has to be kept continuously in order, so that any figures or data obtained in former investigations can be found easily and quickly. Of course, all this costs money, it is true, but experience has shown that it is money very well spent, if the organization described has been built up in a reasonable way and sufficient time has been allowed to let it grow up as the basic facts accumulate. In the same way what has been called the laboratory may also be developed, starting perhaps with the necessary equipment for making the basic chemical analyses and for testing the physical properties of materials, and finally containing modern apparatus for X-ray investigations, etc. The Technical Inspection must not only know the standard methods of testing materials, but it must also be able to develop new methods to suit the purposes of the works concerned where standard methods are insufficient or do not exist. It is the close touch which the laboratory has with the works and their practical requirements which is of such importance and value.

Work in Progress and Finished Parts

When inspecting work in progress and finished parts of products composed of many single pieces as, for instance, is usual in the metal-working industry, it is necessary to decide whether to have centralized or decentralized inspection, i.e. whether the parts to be inspected should be brought to the inspector, or whether the inspector should go to the material and follow its flow through the various processes of production. This question does not arise in many industries, such as the metal-producing industry, being decided by the nature of the products. Decentralized inspection is usually preferred, because it does less to disturb and interrupt production, and transport difficulties and costs are smaller, but there are undeniable advantages in centralized inspection, especially the possibility of better supervision by the man ultimately responsible. The decision depends very often on the local working conditions. For example, the more refined the products become, the more important is it that the inspectors should work under good and undisturbed conditions. Lighting is often a problem, especially in old works built without any regard to making the best of daylight; artificial light is not always a satisfactory substitute. In other cases the comparatively rough nature of the production, with its dust and changes of temperature, may favour the use of partly open shops where the conditions will be anything but suitable for careful inspection.

With decentralized inspection the contact between operator and inspector is naturally close and this can be psychologically very important if the inspector is the "right" man for the job. If it is decided generally that inspection should be decentralized, it is important to find out the "strategically correct" places for inspection to take place, usually just after the machining of the more important dimensions or after the completion of the more important processes; but there are exceptions even to this apparently obvious idea, as the nature of the product, the training of the operators, etc., may make it desirable to change the places of inspection from time to time. This has found its expression in the arrangement of the "travelling inspector," who alters the place in the production line where inspection takes place, just as the necessity arises, even taking with him the whole equipment of his workplace, table, chair, writing desk, gauges, measuring instruments, etc., on a platform on wheels so that it may be quickly moved to any position in the works. The more the organization of production and inspection settles down to deal with a predetermined and constant flow of work, however, the more the advantages of the "travelling inspector" disappear, and he may therefore be considered as a passing phase in modern workshops.

Statistical Quality Control

The most important innovation to be introduced into inspection during the last one or two decades is based on considering whether it is necessary or even advisable to have a hundred per cent inspection during the progress of work or of the finished articles or whether it is not sufficient, or even preferable, to select samples on some predetermined plan and to test these only. From this consideration a new technique has been developed which is to-day unfortunately known under the name Quality Control, although this term has been used before and is still used for something else of which the new technique is only a part. Attempts to correct the mistake by using the term Statistical Quality Control for the new technique have had little success. It is not very easy to understand the principles on which this new development is based, as most of the numerous publications which have appeared about it are written by specialized scientists, who overlook the fact that the average production engineer or inspector has not the knowledge or the time to study the principles on which they have developed the new method.

The author is of the opinion that the best source from which to obtain an idea of what Statistical Quality Control means is still the introduction which was given by Sir Frank Gill, the champion of the new technique in this country, to a joint meeting of the Institutions of Civil, Mechanical and Electrical Engineers on the 15th April, 1942, and which is therefore quoted here verbatim.

(1) *Introduction*

The following is a simple, popular, but incomplete exposition of the statistical foundations of quality control, easily grasped by busy engineers.

We have not the necessary knowledge to manufacture articles in large quantities and all having identical essential qualities, therefore tolerances are introduced into specifications. If a number of similar articles are taken, and some quality, illustrated here as a dimension,[1] is measured in each, we get a frequency distribution such as illustrated in Fig. 21A, where the majority of the articles cluster round about the average measurement.

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[1] For brevity, these remarks do not refer to quality control as related to proportion defective.

Using the data given by these measurements we can, by the probability theory, convert this figure, obtained from a relatively small number of measurements, into what it would be if a very large number were taken. This is shown in Fig. 21B. The area in Fig. 21B has been very exhaustively

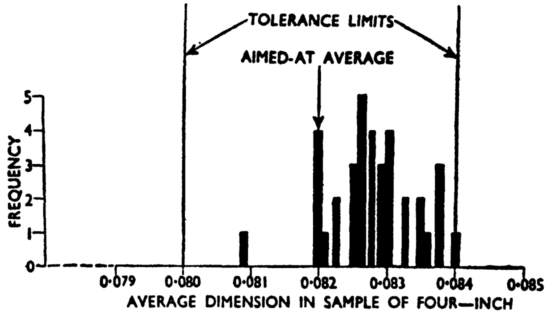

FIG. 21A. FREQUENCY DISTRIBUTION

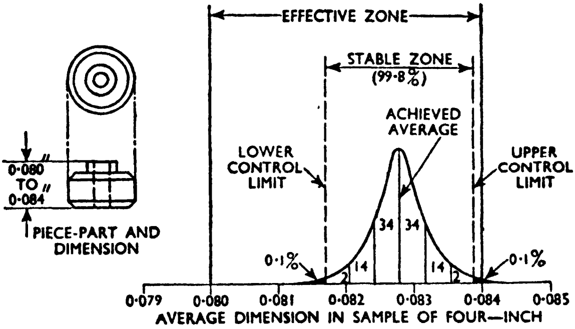

FIG. 21B. PROBABILITY CURVE

studied and its properties are so known that it may be applied to a chart of the type shown in Fig. 22, on which frequent measurement, for example, the product of a machine tool, can be plotted. This chart shows (*a*) the normal dimension required, and (*b*) the plus and minus tolerance limits. In Fig. 23 three lines are added to the chart: (*c*) the average dimension actually produced, and (*d*) two statistical control limits, rather finer than the tolerance limits and set quite easily by the simple application of multipliers to the figures obtained from the measurements. The multipliers are based on probabilities.

The chart shows, as news and not as history, current information of the degree to which the desired qualities are being embodied in the product, the extent to which variation must be expected and be therefore inevitable and harmless, and the cases where samples show harmful tendencies or actual "action points," so giving warning for instant action before the tolerance limits are reached. The main object of quality control is to improve the uniformity of the product up to the point where "a state of control exists," that is when all, or substantially all, the plotted points lie within the two statistical control limits. When this is attained a train of benefits accrues.

In broad outline nothing in the new technique *appears* to be very new;

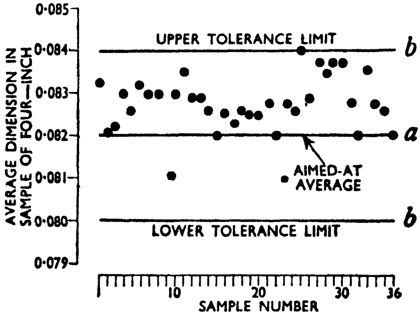

Fig. 22. Direct Plottings

but there *is* much in it which is different from the ordinary practice of factories. The following table shows the steps in parallel columns—

Without Quality Control	With Quality Control (Measurement)
Inspector	Inspector
Takes samples when he thinks necessary	Takes samples regularly—to plan
Measures	Measures
	Records
	Averages
	Plots
	Reports cumulative averages
	Records cumulative ranges
	Uses probability control limits
	Exhibits continuous news, open to production department, of quality being produced, thus tending to prevent rejections
Uses purchase specification tolerances	Uses purchase specification tolerances
Passes or rejects	Passes or rejects

These changes are not difficult to make; but their effect is important.

(2) *Application*

Prolonged research has established so much that a tool has been made and, as is the case with many tools, can now be used by those who know little of the design. The opening instructions are what must be known, not a checking up of the research already done. Anyone interested may study the statistical fundamentals and will be the more expert for so doing, but it is wrong to think that nothing can be done to apply this technique until statistical experts are available.

Statistical assistance is useful if coupled with factory experience; but care is required to prevent an unpractical mind from disturbing production. What, therefore, should be the attitude of the manufacturing man wishing to investigate this technique, yet unable to add statistical knowledge to his factory experience? Many factory engineers are competent to take the simple directions and to do useful work without a statistical expert, if one is unobtainable; while so doing they will find their knowledge expand, so that there will be fewer cases in which such help is required, thus relieving the difficulty caused by the assumed fact that not very many statistical experts with factory experience are available.

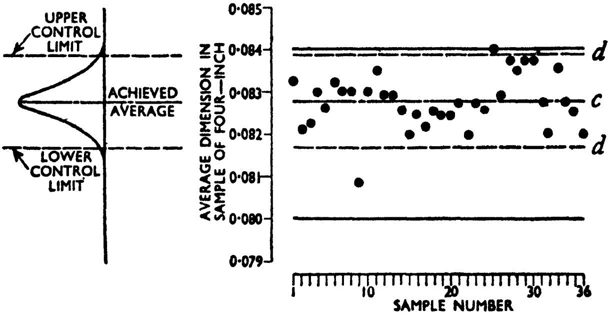

FIG. 23. CONTROL LIMITS

Factory engineers should at once begin to study the rules for the application of quality control and not by studying the statistical foundations. They should accept this foundation as already established and proceed with practical study.

(3) *First Steps*

The first steps seem to be—

(i) To study War Emergency Publication No. B.S. 1008. This Standard is simple and direct and will enable the factory man to set up quality control charts, using measurements, and to put such charts into practice.

(ii) To decide which of the products on which the factory is engaged is suitable for the use of quality control. Obviously the first thought is of repetition work, whether continuous flow or in batches of considerable size.

(iii) To answer the question, "Which cases and how many for a start?" The short answer seems to be, "Look for cases where the rejects are high; select a few of the most troublesome of these, and set up charts for very few, say not more than six at first"

(iv) To explain fully to all concerned what is being done and what is aimed at; the explanation should be so full that the element of surprise (so often the cause of misunderstanding) shall be absent.

(v) To make detailed written instructions for each step and each class of shop personnel concerned.

(vi) To begin plotting charts of the selected processes for a few days without putting in the control limits. Where no queries arise, perhaps one week will be sufficient.

(vii) To use the average of the averages given by the trial period, set up the control limits, and maintain the charts.

(viii) To introduce quality control gradually in those places where it is appropriate as a regular part of the factory routine.

A sort of primer illustrating this method of starting work will shortly be available.

(4) *Should Quality Control be Introduced During War-time?*[1]

This war is unlike any other in our experience; whether we recognize it or not, all are involved in a struggle which affects all we value and may affect our very lives. Effective, fast production is tremendously important, yet to-day production is subject to numerous unusual causes of hindrance such as: less skill in labour, poorer maintenance, fatigue, illness, worries, less tractable materials, or substitutes for normal materials. All these adversely affect manufacture and the results may be summed up in two words, "more rejects"; or, better still, more man-hours, machine-hours, etc., rendered ineffective through rejects.

Less rejects will, in effect, give reduced waste in man-hours, machine-hours, space, materials, etc., and so result in greater production; waste is always costly. This is surely a strong appeal to all interested in speed and in effective production.

Because the effectiveness of a firm's inspection can be so well judged by the control charts, quality control should be a method which appeals to those interested in the philosophy of the Services Inspection Departments, namely, that when they are satisfied that a firm is doing a first-class inspection job, the Services will leave inspection to the firm. If a firm has a job suitable for quality control and uses it, not only should the quality of its product improve, but it will also have clear evidence of the quality of its inspection which can be used to justify the Services Department leaving inspection to the firm, with full confidence in the result. Obviously, however, the mere use of quality control charts does not justify leaving inspection to the firm, or inspection by samples, unless the quality has been brought into the "state of control."

To enlarge on this picture it would be as well to add a further quotation taken from an article given by B. H. Dyson in October, 1942, in the *Technical Bulletin of The Institution of Production Engineers*—

It will be appreciated by many production engineers that this method of inspection control is no new feature. Mr. A. Stewart's book on *Economic Control of Quality for Manufactured Products* was published in America in 1931; Dr. E. S. Pearson and also Dr. B. R. Dudding have written several contributions to this subject from 1933 onwards. . . .

A step forward has been made by the British Standards Institution in *Quality Control* (British Standards Institution, B.S. 1008 : 1942).[2]

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[1] The war has been over for four years. Should Section IV of Sir Frank Gill's introduction be omitted from this reproduction? After having read it, the reader will understand why the answer to this question is "No." "Hostilities" may have ended, but the "war" is still going on.

[2] Also mentioned in the above quotation from Sir Frank Gill's paper.

The original B.S.I. publication on the subject was that published in 1935 (B.S. 600) under the title *Application of Statistical Methods to Industrial Standardisation and Quality Control*, by Dr. E. S. Pearson.

This present publication is a reproduction of the *American Defence Emergency Standards* issued on this subject at the request of the American War Department in December, 1940. The publication is in two parts—

1. Guide for Quality Control.
2. Control Chart method for analysing data.

Part 1 is an introduction to the scope and principal uses of control charts; the establishment of control limits, and the method of representing recorded deviations from standard on a control chart is featured by illustrations and sample charts.

Part 2 deals with analysing the charted information for the purpose of translating the visible record of events into the knowledge necessary to affect control.

The various types of control charts are described and advice on how to construct these charts is explained in a clear and concise manner by three instruction sheets.

In the appendices, formulae and tables are given for the use of deciding on, computing, and presentation of control chart lines for various applications of quality control.

It is interesting to note that there is a paragraph under the heading of "Co-operation between the technical man and the statistician."

Quality Control Charts, by B. P. Dudding and W. J. Jennett (British Standards Publication No. 600R : 1942).

In the introduction to this publication the authors have taken the initiative in presenting their subject in a practical manner to the production engineer. They state "a characteristic feature of quantity production in modern industry is repetition work; that is, the objective is the reproduction of articles of close similarity. Nevertheless, it is impossible to achieve absolute similarity, whether similarity be judged by dimension, such as a diameter of a bolt, or the pitch of a screw, by strength as in cloth or wire, by electrical resistance as in parts of telephone equipment."

Even those die-hard production engineers who would view a system of statistical control using graph paper and lines to control the quality of their products with very great suspicion are encouraged to read on when they come to "once it is conceded that variability is bound to be encountered in a manufactured product, some action must be taken to keep the degree of variability under observation."

It is fully appreciated by the authors that in many circumstances one hundred per cent inspection is vital, whereas in other cases sampling inspection can be the procedure. Nowhere do they attempt to explain their claim that statistical control is an alternative to, or will obviate, inspection, but they clearly indicate the importance and necessity of controlling quality by effectively making use of the inspection information rather than just recording it in an unintelligent manner. The purposes of statistical control are stated as—

1. To provide a ready means of helping to distinguish between real and apparent change in a product.
2. To provide early warning of a new source of variation, or an increase in the variation due to a known source.

Section 3 of the book deals with the control of manufacturing procedures and sets out to indicate how, in the majority of cases, the lack of control is found to be due to lack of (or limitations of) information and knowledge of the conditions prevailing.

Section 4 illustrates how actual recorded product variations can be plotted on the control chart to give a visible trend of the quantity being produced.

In Section 5, information is given on the procedure for calculating normal frequency variations and the variation of averages; also standard deviations for use in the preparation of the control charts.

The practical application is dealt with under Section 7, under the heading of "Examples from Factory Practice," in which suggestions on how to introduce control charts in the factory are given.

The book concludes with numerous tables on deviation calculations, control chart limits, etc., with an appendix headed "General Definitions," under which a dictionary of control chart terminology is given.

It can well be recommended as a "standard work" prepared in an interesting, clear and concise manner on the practical application of statistics to control the quality of production.

Finally a more recent publication may be mentioned, which is of special interest for the readers of this book. First, because it can be considered as continuing and expanding what has been said here of the duties and organization of inspection; secondly, because it contains not less than fifteen case histories of control charts, which are excellent practical examples; and thirdly, because it is written in an easily readable language leaving aside mathematical theories without being in any way unscientific. Its title is *Control Charts in Factory Management* by William B. Rice.[1] Special interest attaches in particular to the five reasons for installing statistical quality control—

1. Wherever like products are turned out in quantity, control chart techniques are applicable.
2. Variability exists in every repetition operation.
3. Quality must be built into a product; it cannot be introduced through inspection.
4. A state of control is not usually found in practice.
5. A state of control must be established at a satisfactory level before maximum efficiency on the operation can be obtained.

Considerable attention is also given to explaining the differences between "sorting" inspection and "sampling" inspection.

The selection of samples to be inspected, however, should be based on mathematical theory, as in Statistical Quality Control; the inspector need not even know the scientific basis for what he does. "Sorting" inspection is a term used to describe what is commonly meant by routine one hundred per cent inspection. It implies that every piece produced is examined and classified as either acceptable or not acceptable with regard to a given quality characteristic. If sorting is performed in a plant it may be at any stage of the process, but it is done most frequently as the last act of inspection just prior to storage or shipment of the product. Sometimes sorting is impossible, as in tests to destruction, and it is especially necessary in these cases to apply scientific principles of sampling inspection. If this maintains required quality on critical items in the case of tests to destruction, why will it not achieve the same result in tests which do not harm the article tested? Why should a successful technique be limited to cases where it *must* be used? Why not extend it to all cases where it *can* be used? These considerations are logical and must be taken as cogent.

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[1] Published 1947, by John Wiley & Sons, Inc., New York, and by Chapman & Hall, Ltd., London.

Another interesting problem is dealt with in the concluding chapter of the book under the heading "Organization of a Statistical Quality Control Program." It contains suggestions on how this kind of control should be developed after careful consideration of the working conditions has proved it worth while to introduce it.

The importance which is attributed to the technique of Statistical Quality Control may further be illustrated by the fact that a special section of the Eighth International Management Congress, Stockholm, 1947, was devoted to this subject, on which three papers by American and British experts were delivered.

It is not possible within the scope of this book to go further into Statistical Quality Control, but it is hoped that sufficient references have been given to enable the reader to obtain any further information he may need. There is, however, one important point which should be mentioned here and which is especially appreciated by the production engineer: in certain instances the control charts enable a forecast to be made, sometimes weeks or months ahead, of when a deterioration in production is to be expected so that steps can be taken in good time to prevent it occurring. The approach of the points which mark the average result of each sample tested to the control limit lines are clear signs that something is happening to the production, which may not yet be dangerous, but will certainly become so if it is not found and removed.

Finished Products

The inspection of finished products takes a special place in the sphere of inspection. To the checking of such things as finish, dimensional accuracy, etc., must be added the tests applied to the functioning of the product as a whole, such as the tests of efficiency, which is usually guaranteed in some form or other in the contract concluded with the customer. Sometimes the amount of the final payment received by the supplier may depend on the efficiency of his products, which may even be completely rejected if the efficiency does not reach a guaranteed minimum. As the question of efficiency is closely connected with the nature of the goods produced it is obvious that any general information on how this testing should take place is impossible. A test house or test shop is, of course, required where the products can "work" under conditions as similar as possible to those to which they will be exposed in use, while simultaneously measurement of the efficiency takes place. In the case of prime movers, such as steam or internal combustion engines, the brake horse-power can be measured and related to the work supplied as heat in the steam or fuel. For machine tools detailed acceptance tests have been developed concerning the tolerances in the machines, speeds and feeds to be obtained, driving power required, etc. Pressure vessels have to be tested for strengths and absence of leaks under pressure of steam, water, air, etc.; typewriters to ensure that all the letters fall on the same horizontal straight line and that the various controlling mechanisms are working correctly; rifles and similar weapons, that they shoot accurately and consistently along their line of sight, etc. The experts have the job of developing the test house or test shop so that these investigations can be made in such a way that the customer will be satisfied that the results are scientific and unbiased. The test house must not be allowed to incur unnecessary costs, a point which is often overlooked. The costs of testing can sometimes be comparatively easily reduced or even completely recovered by ingenious technical means. For instance, if prime movers such as steam or internal combustion engines are being tested they can be coupled to an electric generator so that the power they produce on test can be used for relieving the power station. Where it is necessary for each apparatus, engine, or machine to be tested, it is usual to make a test report of the results, a copy of which is sent in some cases to the customer, but which in any case should be kept as it forms a useful basis of argument if later on any difference of opinion about efficiency should arise.

Finished goods require packing, which may be unreturnable, its costs being included in the price of the goods delivered to the user—e.g. the cardboard boxes and paper wrappings in which vacuum-cleaners or children's toys, etc., are packed—or it may be "returnable," in which case it is usually a substantial packing case of timber or fibre construction, charged separately from the goods it contains, such charge being repaid on return of the case in good order to the supplier. Packing of either kind should be carefully adapted to the kind of transport used and to the goods to be protected. Inspection should see that the proper packing for road or rail, river or sea, etc., is used, and should determine the best method of packing in each case. Of course it is not difficult to make a package to resist nearly all possible hazards during transport by land or sea; but again economy demands that it be "just good enough." The inspection must find out methods that are a successful compromise. A rather unusual example of a packing test occurred in the author's experience. A high tower with a flight of winding stairs, formerly part of an old fortress, was still in existence in a typewriter factory. A typewriter well packed in a wooden box was allowed to roll all the way down these stairs, and by gradually decreasing the quality of packing before each test, the minimum amount of packing was found which would preserve the typewriter from damage so that it arrived at the bottom in good workable condition.

CHAPTER XXV

THE STANDARDIZATION DEPARTMENT

THE function of standardization has frequently been mentioned in these pages, but it would be wrong to believe that all the implications of this idea have been covered. It exerts—or should exert—much greater influence on the whole of industrial, even on human, development than might at first appear. To make this clear let us try to go back to the origin of standards, which are not an invention of modern times but are perhaps nearly as old as mankind itself. The man who first used his foot to measure a piece of land, so that the boundaries between his land and his neighbours' would be more accurately marked, used a standard from which the English measure of length has derived its name. By mounting the stone wedge used for splitting wood in a stick, the form of the axe which is still used was developed; the device has standardized the way in which wood is split, and at the same time to some extent has standardized the tool. Out of all the possible methods of splitting wood there was selected the one which seemed from experience to be the best and most generally effective and this gave a pattern for all successors. Thus later comers did not have to think all over again about these possibilities; the problem once solved was solved for ever. It was done so that a group of men living together could regulate either their relationships with each other or their utilization of material things. Such problems, occurring again and again, are to be found in all branches of human activities and their solution in a manner which may be applied generally is the basis of standardization.

The Meaning of Standardization

These ideas are reflected in one of the many definitions of standardization which can be found in literature, and which is repeated here because it is perhaps the most comprehensive: Standardization is the regulation or establishment of what is approved as good or valuable and therefore shown to be necessary by experience and consideration—weighing against each other the demands of design, production, economics and psychology.

It is possible to distinguish between *social standards* which regulate the relations of men to one another, and *material standards* which refer to material things. Both are important for an industrial undertaking although it is usual, especially in technical circles, to attribute the term "standard" almost wholly to the second group, which is also the group mainly dealt with in these pages. The first comprises—to give a few examples—language, calligraphy, systems of notation, laws, regulations for trade and commerce, measures of size, weight, temperature, money, etc. It may be mentioned that the laws of physics and other natural sciences cannot be classed as standards because they are usually, but not indisputably, considered of universal validity and independent of the life and work of mankind, although it is the revolutionary development of these sciences in the last decades which has given rise to the witticism that scientific knowledge is the raising of to-day's error to the importance of a universal law.

Characteristics of Standardization

Some characteristics can be found, common to all sorts of standards, that explain their existence and purpose better than any definition can.

The first has already been mentioned: standards are closely connected with the *evolution of mankind.* They may even be regarded as a measure of the culture of a nation, for they mark the extent of the general knowledge which has been accumulated and classified, and they enable it to be used by those incapable of understanding it and release the time and energies of those who can for its further increase.

With standards—as long as they are in force—*periods of arrestation* occur, but they are not and should not be final stops to progress. Just as the architect provides an occasional landing when building a high staircase to enable one to acquire new energy for further climbing, so in the evolution of civilization pauses are necessary which are to be regarded not as an end in themselves, but as the beginning of future developments. Uninterrupted progress, that is to say continuous change, would use up too much energy and ultimately lead to exhaustion. It is the function of standards to prevent this. They are the foundations on which we stand, working for progress; but we make this progress only when we are sure that the new ideas and inventions represent a real increase in common advantages. Therefore it is clear that standards are not sterile creations as is sometimes said of them. They pave the way for progress, giving the best that is known at the moment to the whole of the community without any restraint preventing continuous change, but at the same time promoting steady evolution.

Another peculiarity of a standard is that it is not the work of a single person, but the result of enlightened *co-operation.* A number of people become dissatisfied with the lack of uniformity in some product or process. They wish to avoid uncertainty and demand a compromise between conflicting interests and the elimination of struggles that expend energy which could be better employed for other purposes. Therefore standards are an embodiment of the great idea of co-operation which is, or should be, the foundation of modern society. Without standards our State, our commerce and our traffic would be inconceivable. Everybody knows how important it is for the maintenance of the bonds uniting the British Commonwealth to have a universal language; everybody is acquainted with the difficulties arising in international commerce from different languages or monetary systems, from varying systems of weights and measures, from dissimilar railway gauges, and numerous other instances of lack of reasonable uniformity.

Negotiations between the governments interested are conducted often enough to overcome such obstacles or to diminish their disadvantages. Standards are important not only for one country but also in its relations with others and the International Standards Association formed by the various national standards institutions has the important job of conducting the necessary negotiations and so creating a better understanding internationally.

Effects of Standardization

One of the most important effects of standardization is the saving of material and intellectual effort. As already mentioned a standard is developed by a collection of people who have a greater experience than any single person can possess and who are selected with regard to their special experience in the case in question. The formulation of the standard requires an amount of labour which is only justified economically by the repeated and general use subsequently made of it and the recognition that it is the best-known solution available for common use to a problem or a series of problems.

All these characteristics of standards—their connexion with the evolution of mankind, forming the necessary periods of rest in progress, results of co-operation, saving of material and working time—are as a whole to be found in the different standards used in industrial undertakings, where perhaps not one of the different functions, offices and workshops is out of touch with the idea of standardization, especially if not only material but also social standards are taken into consideration. Conventional methods for the development and use of drawings, printed forms for orders, stores requisitions, wage tickets, invoices, costing papers, statistics, etc., regulations for workers and employees regarding their conduct in factory or office, all these things are standards in the sense explained. The work of design, production, testing, selling and purchasing is influenced by the idea of standardization. Taking all this into consideration, together with special technical standards of a particular factory—perhaps conveniently understood on the whole as "works standards"—and the common standards of the British Standards Institution as far as they may be of value to the works in question, there is a very great number of standards about which a continuous survey is necessary and their reasonable and consistent use throughout the whole concern has to be controlled.

The Book of Standards

The survey is rendered comparatively easy by a "book of standards," kept in loose-leaf or card-index form, and a special department or person should be in charge of the development and the keeping up to date of this book and the control based on it. But before dealing with the position and activity of this department, it may be advisable to discuss somewhat more in detail the important part the book of standards may play in the whole organization of the works when used in the right manner. By studying it the newcomer will gain a quick and accurate insight into the circumstances surrounding him at the very beginning of his work, and the employee already working in the concern will find assistance in developing his work to fit in with existing methods. The standards have yet another very important function, especially in times which are characterized by the necessity of quick changes in methods or customs to keep up with market fluctuations. If all resulting alterations of standards are reflected in the book of standards, it gives a true picture of the development of the stages by which the existing modes of working have been reached. It is clear that it is also possible to find out whether a false step has been taken at any time or whether mistakes have been made necessitating subsequent rectification. By studying these records everyone learns to avoid such faults and to recognize the reasons why any particular method is used, any special design chosen, or why instructions are given in a certain form. The whole history of the concern is to be found in the book of standards and so the lack of continuity is avoided which occurs in many cases where a man, possibly of long service, is lost by death, by dismissal or by his accepting a position in some other undertaking and has to be replaced. This is the more important the higher the position the man has occupied. It is very seldom found that all that the former holder of a position has done is wrong. Changes should not be made without a full knowledge of the reasons for the adoption of earlier methods; a complete change of practice merely for the sake of change, which is effected only too often, has frequently entailed great losses. A very careful hand is needed in guiding an industrial concern from one state to another even if the former state is bad and the new is expected to be better. In these circumstances the book of standards, if carefully kept, may be a very great help to a new manager.

Considering standardization in this way in the broadest sense of the term, the great similarity with inspection is surprising, and it is reasonable to couple both as closely as possible within the organization of the works. Both functions have to look into, to control and to intervene in nearly all other departments to prevent and rectify mistakes, and while inspection may emphasize the technical side standardization takes economics into account and has a more balanced outlook; a lack of balance can be so extraordinarily damaging in practice. The industrial undertaking is often compared with a human being, whose head or brain is represented by the offices and the body by the factory, the workshops and the technical equipment. To enlarge this comparison, standardization and inspection should be spoken of as the conscience, controlling and co-ordinating the activities. Standardization helps to develop the best methods of inspection and then fixes them as standards. The great affinity between both functions throughout is obvious, one conditioning the other, yet able to attain the best possible results only when working closely together.

For this reason they should in principle be coupled with each other within the organization of the works and be given a much higher and important position than is usual in practice. Only too often is standardization considered as a mere appendage of Design, perhaps at best also of Production Planning and Control, inspection as an appendage of Production. If this is so then it is not possible to obtain, especially from standardization, the whole of the benefits otherwise available. Inspection and standardization, combined under one member of the staff, should be given a position parallel with Design, Production Planning and Control, and Production proper, directly responsible to the top management. Again it may be added that even in this case it is necessary under all conditions to have regard to the development of the works and to the personalities available, but the experience of the author leads to the conviction that it is, in general, beneficial to give to the "conscience" of the concern the status recommended, so that everybody has to listen to its voice.

CHAPTER XXVI

MISCELLANEOUS PRODUCTION MATTERS

OUR final chapter in this survey of the Execution of Works Orders deals with a few miscellaneous problems that should receive attention.

The Experimental Shop

This place is as good as any to make some remarks about the experimental shop, although it has actually no pertinent connexion with inspection and standardization; it is, however, sometimes run in conjunction with the test-house or test-shop and thus has led to the erroneous view that the organization of the two shops should have something in common. Actually the experimental shop should be considered as something apart from the rest of the organization, especially of the Production proper; it is to some extent a trial to the rigid organizer, as nearly all regulations and organization applying to other shops should be annulled for the experimental shop. It can, therefore, be a bad example for the other shops, which they are only too ready to follow if any instruction or regulation is found irksome. This may be regretted but cannot be altered as the nature of the work in the experimental shop does not allow it to be closely linked with the organization of the rest of the works.

It is the job of the experimental shop to carry out the construction of prototype models and full-scale prototypes of new specialities, to try out new designs for more familiar articles of production and to test them so that they can be put into regular production as quickly and with as few alterations as possible. It is obvious that for the experimental shop it is unnecessary to prepare detailed drawings, nor is it necessary to have elaborate production planning with carefully designed tools and devices, etc. Besides, comparatively frequent rejects will occur during these experiments and designs may be altered at short notice. In fact it is hard to imagine conditions further removed from those which should obtain during a regular production. If, therefore, the regulations governing standard production were to be enforced in the experimental shop, they would give rise to difficulties which would result in endless delays. Thus it is only reasonable to treat the experimental shop as a unit independent from the rest of the works and to allow the manager to sign the requisition slips for the raw materials without waiting for those issued by Production Planning and permit wage tickets to be valid if they are signed by him. His shop must contain the main machine tools such as lathes, planing and drilling machines, etc., which must be at his disposition without any interference by Production Planning. It is not necessary for the experimental shop to be housed in a separate room or building, although this is always to be preferred. It can, especially in small or medium-sized works, be a part of some other suitable shop, but this will make it more difficult to separate the organization of the experimental shop from the rest of the works, where it may have a bad influence because of its apparently easy-going habits.

It is, of course, essential that the manager of the experimental shop be thoroughly trustworthy, one who will in no circumstances misuse his authority, which is larger than that of other employees in a similar position. First of all he should never allow any work for the production proper to be carried out in the experimental shop; the number of workers under one foreman must be kept comparatively small in order to facilitate supervision; the men should be chosen from highly-skilled workers because of the variety of jobs they have to do, and they should be of good character so that they do not misuse the greater liberty which must be given to them because of the nature of their work.

Another often-discussed problem is: under which chief executive should the experimental shop be placed, i.e. who should be responsible for its work to the general management? This is again one of the problems where it is necessary to avoid being dogmatic. Obviously the right man should have experience in the new developments taking place, but it is probably more important that he has the right human qualities combined with a scientific outlook. It may be the chief designer, the works manager, the chief inspector, or somebody else in a similar position. It is even possible that there may be a separate independent designs office for the experimental shop, subordinated to its manager. In this case the experimental shop may develop into a self-contained small unit, the management of which should, of course, work with all other departments as far as possible, but is to a large extent independent of them because of the peculiarity of its work. Whichever way is chosen, however, one point must be clear, the experimental shop is always difficult to fit in with the organization of the rest of the works, and all concerned must strive to be especially co-operative in order to make a real success of this important work.

The Dispatch Department

It has already been mentioned that the finished product after assembly and test must be packed to protect it during transport. In many cases the articles must be dismantled or taken to pieces and greased or painted with a rust-preventive before the actual packing can be done; goods can then be either stored in a warehouse or brought immediately into the Dispatch Department.

In the same way that the whole supply of materials to the works has to be obtained through the Purchasing Department and goes through the Receiving Depot, so the Dispatch Department has to control the movements of the finished goods to the warehouse and their eventual transport to the customers in collaboration with the Sales Department. The organization of the Dispatch Department can be dealt with briefly, as it is very similar to that which supplies the works, but in reverse.

The Dispatch Department is instructed to send goods to a customer by means of the dispatch order, which in nearly all cases is in writing and is usually issued by the Production Planning Department, but may come as already mentioned from elsewhere, direct from the Sales Department if the dispatch takes place from the warehouse stock, Production Planning being informed of this dispatch by means of a copy of the order. In the case of materials which cannot be accepted for some reason or other, and have to be returned to the suppliers, the Purchasing Department will give the dispatch order, and, in the case of parts of equipment that are to be repaired outside, it will be given by Production proper or the Production Planning Office. Dispatch orders may thus originate from many different departments in the works and it will be best to develop a standard form which can be used by all of them. It should have space for the instructions on how the consignment is to be sent, e.g. road or rail, and whether in own, customer's, or rail or road company's vehicles, type of packing required, whether customer or supplier pay for transport, etc. If the goods are going abroad, further instructions will be needed on packing, e.g. against tropical climates, how they are to be consigned, e.g. F.O.B., C.I.F., etc., and on payment of customs duties and so on. The Dispatch Department must also be told if they must limit the size of their packages, conditions which may be imposed by the facilities available at the ports through which they have to pass or because they have to finish their journey carried by porters or on the backs of pack animals, etc. It is obvious that the dispatch order should be issued as early as possible, so that all necessary preparations can be made, supplies of packing materials prepared or ordered, and specialized vehicles obtained, etc., so that the delivery of the goods is not delayed by waiting for these activities to take place after they are finished. Experience has shown that, although self-evident, this procedure is often neglected in practice.

The requisitioning of the finished goods from the warehouse or the shops is done by the Dispatch Department. Spare parts are requisitioned from the spare part store, on the same requisition slips which are used by other departments except that they should be marked "Goods for Dispatch" in some way, say, by means of a large rubber stamp.

Finally the necessary dispatch forms must be filled in. These are usually of two different kinds. The first is a dispatch or advice note which advises the customer that the goods have been dispatched, and is sent by post. It should be, of course, a printed form which gives details of the kind of packing, how the individual parcels of goods are marked, and a list of the goods contained in each parcel and its weight and measurements, and finally information on how and by what route the goods are being consigned. Copies of the dispatch note are sent to the department which has issued the dispatch order as an advice that the order has been carried out, to the department which does the invoicing and to any other department which for some reason or other has to be informed of the dispatch.

The other forms that have to be filled in are those which may be required by railway, shipping or air transport undertakings to accompany the goods, such as consignment notes, customs declarations, tax returns, etc.; these are usually printed forms which are issued by the authorities concerned and which must be used.

Work on Site

Work on site consists in the erection, installation, or repair of any engine, machinery, plant, or any part of such equipment, which takes place on the customer's site or premises and usually forms an integral part of the contract for the supply of such equipment.

(*a*) Work on site is a very responsible job, which must be done by workers who, as a rule, can be supervised only unsatisfactorily and irregularly. In addition this job must be directed on most occasions at distances ranging from a few to thousands of miles in such a way that an economic success results. There is first of all the question: to whom should this direction be given? To the engineer who has had the responsibility of calculating and designing the plant from the start, or to somebody who has had no concern with the contract up to now, but has specialized in the work of erection or installation of machines or plants on site? In other words: should this job be given to the Design Department, or to a separate Erection or Installation Department which nevertheless should be in close touch with the Design Department? There are advantages in favour of both solutions, depending on the type of plant to be erected. If the technical peculiarities of the individual plants vary very much so that it is difficult to become acquainted with all the necessary details, it is better for the Design Department to supervise the work on site. If, however, the plants in question are similar to each other in their technical structure and deviations are mostly in size or in layout of the plant, then a separate Erection Department is probably to be preferred. Here again the personalities available will very often be of decisive importance for this issue.

(*b*) The job of managing the Erection Department may be analysed as follows—

(1) To follow the progress of work through the factory very carefully, so that the work on site can be started at the earliest possible moment. If the plant has to be dispatched in more than one consignment owing to its size or for any other reason, then it is essential that the consignments are so arranged that those parts which are needed first arrive first on site. This first consignment should also contain any special tools or lifting tackle needed to deal with it or future consignments.

(2) To keep track of where all the fitters are working and how much longer they are likely to take to complete the job they are engaged in, so that it is known when they are free to be sent to their next job. Mechanical means, such as card indexes and maps with flags for showing where they are working, may be useful as soon as the number of fitters and/or workplaces becomes large enough to warrant it.

(3) Information must be given to the fitters before their departure about the technical details of the plant to be erected with the necessary drawings and descriptions, as well as about site conditions, where to lodge and feed, and anything about the internal organization of the customer's firm which may be useful or essential for the fitters to know. An important point, mentioned before, is that the correspondence between the fitters and their firm should take place on specially printed paper and should always be properly headed and generally kept in the same form. It is best for this reason if they correspond only with one section in the firm, and the Erection Department is the right one.

(4) Special employees have to supervise the work on site by occasional and unexpected visits unless the erection or installation is such an extensive or important job that continuous supervision by a leading engineer is required. This will undoubtedly be an exception; usually one of the fitters will have to direct the work independently, and this consideration shows that it is not possible to promote any efficient and intelligent worker in the Production Department to the position of a fitter on site.

(*c*) The fitters on site, or erectors as they are usually called, must, of course, be capable craftsmen, but for a job as erector qualities of character are of no less, and possibly of more, importance. He must be honest, sober, and a good mixer with all classes of people; adaptable to unusual living conditions; and in addition to all these qualities he must be able, if the occasion arises, to defend with tact and energy the interests of his firm against unjustifiable claims. It is clear that great care must be taken in selecting the right men as erectors and, to get the best out of them, they must be supported and mutual confidence increased in every way possible. General service instructions, should, of course, be drawn up, but they should be in the nature of guides and should not attempt to go into details which should be left to the tact and common sense of the individual. Their job should as far as humanly possible be made easier by reducing to a minimum the writing work which is inevitably connected with it. This can successfully be done by using printed forms wherever possible. The erector on site has, in addition to the work of installation, the important duty of making reports regularly to his firm in writing; he has to keep the wage pay roll with the necessary vouchers for his subordinate workers; and he is responsible for the tools issued to them and for recording these issues. Keeping the wages in particular can develop into a responsible and time-taking job if he has to keep information not only about his own wages but also about those of subordinate workers. If he is also entrusted with the engagement of these workers on site—which is frequently the case in order to save the fares—he has to see that all necessary formalities are observed. It is obvious that he will incur expenses on behalf of his firm and he must make returns of these so that they can be recorded and repaid to him. These examples, which could be easily multiplied by going into still more detail, indicate clearly the many duties which fall to the lot of an erector and sufficiently justify the very careful selection needed to choose the right man for this job.

When dealing in the wage office with the wages of the outside workers much the same rules have to be followed as when dealing with any other wages, although there may be adaptations to suit the somewhat changed working conditions. It seems to be unnecessary to go into these details; it should only be remembered that not only must the income of each worker be separately recorded but also a record must be kept of the total wages paid out on each contract. Erectors are nearly always paid a fixed hourly or weekly rate, but there are rare cases where the erector "contracts" to install the plant for a lump sum agreed before the erection begins. It seems quite superfluous to point out the dangers of this method, which seems to require an almost superhuman trustworthiness on the part of the erector or an inspection of site work far stricter than most firms can afford, if it is not to lead to scamped and unsatisfactory work.

PART V

ECONOMIC CONTROL

CHAPTER XXVII

ACCOUNTANCY: ITS INSTRUMENTS AND RESULTS

At the beginning of the final part of this book the reader should call to mind the explanation in the Introduction of the term "Economic Control." Briefly, it means making sure that one of the main purposes of an industrial undertaking, its profitableness, has been attained in the most economic way, i.e. in the greatest possible degree with the least possible means. It is in fact the verification whether and how far the management of the works has solved its problems. It is clear from this definition that economic control must use any method available to find out the actual state of affairs and to put at the management's disposal means of future improvement, i.e. it is a function reflecting the past as well as looking into the future. It is, however, also clear that economic control has partly been dealt with already in the first four Parts of this book, as the opportunity arose to explain methods and means of finding out economic facts so closely connected with measures of organization that to insist on completely separating matters of economic control from those of organization would have made it difficult to understand or explain them.

So it is the purpose of this Part only to give an account of the remainder of economic control, that which is commonly understood under the terms "Accountancy and Costing," and it might be claimed that this should have been the title of this Part. The reason for choosing the title "Economic Control" is that the connexion between the more limited functions of accountancy and costing and those already explained in the course of the first four Parts of this book should be strongly emphasized by the more comprehensive heading, and also because there should be greater liberty to deal with subjects which are not always considered as part of "accountancy and costing." It should be understood—what is by no means always clear in practice—that only by considering economic control as an inseparable part of technical, commercial, administrative, and psychological questions can any advantage be gained which is at all commensurate with the clerical apparatus needed for this control.

The following four chapters try to make this clear; their contents may be summarized as follows—

(1) Accountancy and its results, the balance sheet and the profit

and loss account; the principle of book-keeping by double-entry is briefly explained to give a general understanding of this method.

(2) Works accounts, covering the groupings of costs under various headings. It is at this stage that the effect on expenditure of the close connexion between technical and commercial problems and those of administration, organization, and psychology can be most clearly traced.

(3) Job accounts, dealing with the development of general equations of costs and explaining the contents of production and sales statements as at present mostly made up.

(4) Standard costs, with discussions on the influence of the activity factor on costs, on the calculation of the selling price and on the price policy of the undertaking, and showing how these considerations lead logically to the development of standard costs. A considerable simplification in various branches of cost accountancy can be made by the correct and extensive use of standard costs.

To avoid any misunderstanding it should be emphasized that this survey of accountancy and costing is only to enable the reader to understand the purposes and methods of these functions, not to prepare him to do an accountant's work.

The Importance of Accountancy

The backbone of industrial accounts is the part called "Accountancy," i.e. that part which is concerned with the figures of the past of the undertaking as a whole related to a time basis—week, month, year, etc. This is also the part in which the method of book-keeping by double-entry is universally used. Everyone who has to deal in his work with economic problems should realize that some knowledge of this method and of accountancy generally is absolutely necessary if he is to understand what the effect of his work actually is; how the financial basis of the undertaking is built up, and how it changes under changing working conditions. It is strange in these circumstances that accountancy is often regarded in technical circles with aversion mingled with fear. How can this be explained? It is nearly always the case that the man who criticizes accountancy unfavourably has no idea of what it means. At best he has started to study one of the usual handbooks written by professionals for those who are already in the profession, and has put it aside because he cannot understand the terms used. It cannot be denied that these books are often written in a difficult language, as if the author wanted to keep his topic as a kind of "secret science." And yet any real expert will admit that the great value of accountancy, as of most great inventions, lies in its simplicity and clearness.

"Accountancy is the logical representation of the financial condition of an economic undertaking and of the changes in that condition, so far as they can be evaluated in money."

The original form of capital is ready money; this is changed via raw material, wages and general costs into goods, the sale of which brings ready money into the undertaking, normally in a greater amount than there was originally. (See Fig. 24.)

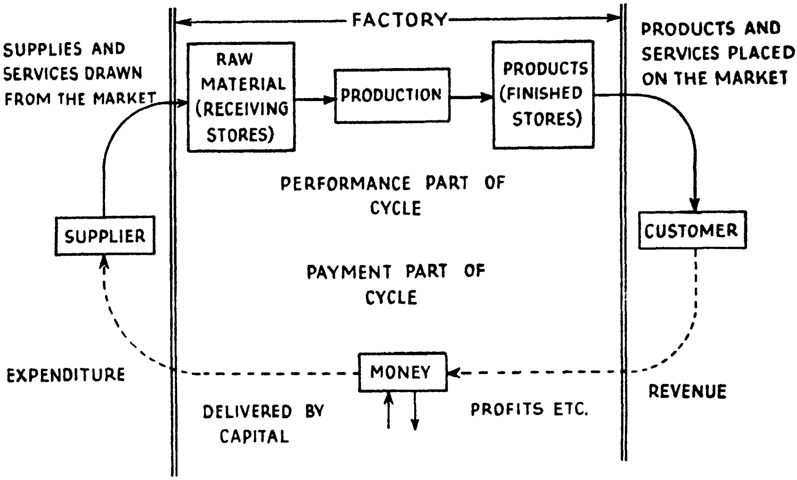
FACTORY
SUPPLIES AND SERVICES DRAWN FROM THE MARKET
RAW MATERIAL (RECEIVING STORES)
PRODUCTION
PRODUCTS (FINISHED STORES)
PRODUCTS AND SERVICES PLACED ON THE MARKET
PERFORMANCE PART OF CYCLE
PAYMENT PART OF CYCLE
SUPPLIER
CUSTOMER
EXPENDITURE
MONEY
REVENUE
DELIVERED BY CAPITAL
PROFITS ETC.

FIG. 24. THE FLOW OF CAPITAL

Accountancy should reflect this flow of capital at once and correctly, and it should particularly show whether the expenses incurred by the undertaking are completely transformed into goods or are used for building new plants or for enlarging existing plants.

The Instruments of Accountancy

Accounts and Stocktaking. Accountancy obtains its results gradually: the first step is to record each individual business transaction in one of the fundamental books. Such "books," in the proper sense of the word, i.e. in the old form in which they were used for centuries, have, of course, almost disappeared. Modern duplicating procedures have replaced them, but this is only a change in the form; the nature of the procedure is not altered. It seems better, for the purpose of explaining the principles, to use the old form. As soon as these principles are clear, the transition to any modern form will not be difficult to understand. Moreover, this method of explanation emphasizes the point that all these modern forms of book-keeping are mere externals which do not touch the essence of the problem.

The sequence of the business transactions in these books is primarily according to time; they are not arranged according to their nature. This second arrangement is, however, already indicated by making a note against each entry indicating what part of the property or what kind of business transaction is affected, i.e. to which accounts the entries must afterwards be transferred. The separation can be effected to some extent by the direct use of various books, e.g. the Cash Book, the Purchase Book, the Sales Book, etc., but again this is no essential feature of this system.

The second step is to transfer the figures of the individual business transactions to a second book, the Ledger, which is not arranged according to time, but in which the nature of the individual transactions is the governing factor, and which is, therefore, subdivided into "accounts." "An account is the continuous representation of the state of one and the same part of the assets or liabilities of the industrial undertaking, showing clearly its increase and decrease in the course of time."

It is of the utmost importance that the accounts are selected not only according to the nature of the undertaking—which is fairly obvious—but also according to the various uses made of the accounts by all parts of the works, especially by the Production and the Sales Departments. Before definitely fixing every detail, the lists of accounts should therefore be submitted to those who are responsible for the main sections of the works and whose activities are afterwards controlled by the accounts, as they alone can be so familiar with all the items necessary for real control as to ensure that nothing necessary is forgotten and nothing superfluous included. Of course, they can only act as consultants; the final decision remains with the accountant, who is responsible for the results of the industrial accounts as a whole.

If d = sum of the debit side of the account
c = sum of the credit side
b = balance

two cases are possible for the balancing of an account.

(1) $d > c$

d	c b
d	$c + b$

(2) $c > d$

d b	c
$d + b$	c

The form of an account, with its debit side and credit side, is so well known generally that no further explanation seems to be necessary; and yet the technician, accustomed to other methods of calculation, often has difficulty in working with accounts. Here everybody is restricted to addition only—subtraction not being allowed—and in consequence the balance (it may be profit or loss) is always shown on the side with the lower total, i.e. the credit balance on the debit side and the debit balance on the credit side. It is, so to speak, as if the accountant knows of the equations $d = c + b$ and $d + b = c$, but does not realize that they can be written also in the form $d - c = b$ and $c - d = b$, a fact which we can also observe in daily life: when we are shopping and receiving the change, the shop assistant nearly always calculates by addition.

The name of the method, "book-keeping by double entry," indicates that no single entry is permitted: if an entry has to be made on the debit side of one account, a second entry of the same figure must be made on the credit side of another account, and vice versa. The rigorous control from an arithmetical point of view, which is so significant of this method, is based on this rule.

Speaking generally three different kinds of accounts may be distinguished—

(1) Stock accounts, showing the change of quantities of materials by receipt and delivery.

(2) Expenditure accounts, showing the spending of means of payment for various purposes.

(3) Result accounts, showing profit or loss when carrying out some business transaction.

Formerly it was quite common not to separate strictly these different kinds of accounts, e.g. accounts of the first and third kinds were mixed and perhaps sometimes called "working accounts." This should be avoided as far as possible. The reason why is best explained by an example.

A special product was in stock at the beginning of a period in a quantity of 1000 pieces at a cost price of £10 per piece. During the period 500 pieces were produced at the same unit cost and 700 pieces were sold at £13 per piece. These transactions were booked in the same account, thus—

	£		£
(1000 × £10)	10,000	(700 × £13)	9,100
(500 × £10)	5,000	Balance	5,900
	£15,000		£15,000

What is the balance? Obviously it is a mixture of two completely different things:
(*a*) There are (1000 + 500 − 700) = 800 pieces at £10 = £8000 in stock.
(*b*) There is a profit of 700 × (£13 − 10) = £2100 by selling at £13 per piece 700 pieces, which have entailed costs of £10 per piece. Therefore the balance of the account is £8000 − £2100 = £5900, i.e. the difference between the cost of 800 pieces and the profit obtained by selling 700 pieces. That, however, cannot be seen from the account in the ledger, which shows neither the quantities, nor the unit prices (shown above at the account in brackets), but only the money sums. The correct booking should be done in two different accounts as follows—

STOCK ACCOUNT

	£		£
(1000 × £10)	10,000	(700 × £10)	7,000
(500 × £10)	5,000	Balance	8,000
	£15,000		£15,000

RESULT ACCOUNT

	£		£
(700 × £10)	7,000	(700 × £13)	9,100
Balance	2,100		
	£9,100		£9,100

Another point to which attention may be drawn is that the accounts should be selected so that as far as possible there is always only one account into which an individual transaction can be booked. This can best be effected if it is borne in mind that costs can be classified from two different points of view, either according to the type of cost or according to the positions in the works where the cost arises. It is usually better when fixing the list of accounts to classify costs according to type. Again this may be explained by an example.

The packing of finished goods may be done in a special Packing Department of the factory. The packing costs are composed of the costs of the packing material, the wages of the packers and the overheads of this department. As a Material Account and a Wages Account, where costs are grouped according to type, exist, a Packing Account, where costs are grouped according to the position they arise from, should be avoided, as otherwise a double booking will be needed—

(1) The wages and materials used in packing will have to be booked each in their appropriate account and, (2) then transferred to the Packing Account. This, however, in spite of the complicated booking, would not show the total packing costs, because the transfer of the overheads—themselves composed of many different types of cost—from the corresponding accounts to the Packing Account causes so much difficulty that it is usually omitted completely or at least not carried out to the full extent. Similar examples are given by the Maintenance Account, the Internal Traffic Account, etc.

This criticism, however, does not mean that there is no way of finding out the actual packing, maintenance, or internal transport costs; on the contrary it will be seen in the course of these discussions that a correct collection of these costs can be obtained easily in another way, by the "statistical method" of cost distribution to centres of costs—as the positions where the costs arise are usually called—instead of the double-entry method of cost distribution to accounts. It is not meant by this that the second method is impossible; it is only more complicated than the first and therefore too expensive and more difficult to understand. In practice there may also be cases where this latter method cannot be avoided—but the beginner in accountancy should have a clear understanding of the extra work involved.

A further instrument of accountancy is *stocktaking*, which is sometimes compared with a "snapshot" of the state of some accounts, while the account in the ledger gives by the sequence of its figures a "film reel" of the changes taking place in the account concerned over a given period. The purpose of stocktaking was formerly twofold. First, it was necessary to divide the balance of any "working account" into two parts, the one produced by a change of quantity, the other by a change of price; secondly, the balance of some accounts had to be checked at a certain time, usually the end of the financial year of the concern, e.g. 31st December, 12 midnight, in order to ensure that the figures in the ledger corresponded to the actual stocks, and to be able to undertake revaluations of these stocks where necessary.

The first of these two purposes no longer exists, as "working accounts" are considered obsolete and are no longer used. The changes in quantity and price of the stocks are now given by the Stock Account and the Result Account respectively. Thus we are entitled to neglect the first purpose of stocktaking in further considerations. It has been mentioned only because it can still be found in many otherwise up-to-date publications, and in order to draw attention to the very fact of its obsolescence.

The other purpose, however, still continues, and it is a very important one, much more important than is realized by many production men who are only too often inclined to consider stocktaking as an unnecessary interruption of their own work and an exaggeration of administrative measures. It cannot, of course, be denied that an unpleasant by-result of stocktaking, when carried out in the usual manner, is some disturbance of production, sometimes even a complete stoppage for some days. It depends on the ability of the man responsible for the organization of the stocktaking how far this loss of time can be diminished; but the production man should not forget that this annual stocktaking offers a unique opportunity for him to attend to the order, tidiness, and cleanliness of his shops. It will be shown later that the purpose of the annual stocktaking and the other favourable consequences can be obtained by the more modern method of "continuous stocktaking," without the disadvantages connected in an industrial works with the usual form of stocktaking, which, however, will be dealt with first.

The *procedure* of stocktaking falls into two parts: the obtaining of the figures of the quantities concerned, and the evaluation of these figures. The first part must be done in the shops, the second is office work.

Now, remembering that stocktaking can be called a "snapshot" of the state of affairs at a given moment, it must take place as quickly as possible and miss no details, for it is necessary to have a complete record with full details ready for the later evaluation, by which time the state of affairs at the time of stocktaking has long disappeared, and mistakes and omissions can no longer be rectified with sufficient accuracy. Furthermore, since this is a work which in large industrial concerns may need the help of scores or even hundreds of men, it is clear that very careful preparation and organization of stocktaking is necessary. How this work is best done can be decided only in each individual case, but it will in general have the following main features—

The works should be divided into districts and one man be responsible for the stocktaking in each district. He must be familiar with the work in the district, but should preferably not be the man who is responsible for the work in it in normal times.

He will have as many assistants as necessary and the work can be distributed among them by subdivision of the district either geographically or according to the material concerned, i.e. one man takes the raw material, another the semi-finished goods, a third the tools, etc.

Carefully developed, printed or duplicated forms show what details are needed for all the materials that have to be recorded, and where these details should be entered. Thus it is necessary not only to give particulars as to quality, weight and dimensions of material, but also the amount of work done on the material in the case of semi-finished or finished products so that the costs of this work can be calculated and the value determined.

Care must be taken to note whether the material in the stocks has already been paid for at the time of stocktaking or not; in the latter case it must be considered as the supplier's property and ought not to be included in the stocks. The same applies to finished goods, paid for by the customer but still stocked in the works on his request, and similar allowance should be made for raw material and finished goods on the way from supplier or to customer at the time of stocktaking.

Further, it is necessary to mark all objects considered to be partly or wholly rejects or obsolete in order to be able to evaluate them correctly and to send them to the scrapheap if they are completely useless.

Finally care should be taken not only that the stocktaking is complete through the whole works, i.e. that no small room or corner has been overlooked, but also that the reports all arrive in the office and are kept there in good order so that their completeness can be checked easily. Whether the stocktaking is of materials, semi-finished and finished goods only, or also includes consumable stores, tools, jigs, gauges, machines, apparatus with all accessories, etc., i.e. the whole plant, depends on the conditions of each case; the management must make quite clear beforehand what it wants in this respect.

It will be obvious from this description that stocktaking can form an excellent basis for clearing the works of excessive materials left in the shops that should correctly be in the stores, broken or useless parts that are kept by some over-cautious foreman, and obsolete products or machinery that could be sold at reduced price or turned into useful goods comparatively cheaply, etc.

The evaluation of the stocks (this expression taken in the widest sense of the word) based on the vast bulk of reports streaming into the office after the annual stocktaking is a big additional job that must be done in addition to the usual routine work and usually needs many hours of overtime unless the engagement of temporary staff is preferred. Everybody knows that both measures have their drawbacks: the temporary assistants need time before they can be really helpful, and the long hours of overtime tend to make the quality of the office work deteriorate during the whole working time; but the author does not know any other way to overcome the difficulties which arise from this sudden run of work on the office.

On what lines to carry out the actual evaluation will be dealt with later. Here it may be sufficient to mention that raw material is usually valued at the price at which it is put into stock; semi-finished and finished goods at production costs; and all items that belong to the plant at prime costs less a suitable amount for depreciation. But it is the custom—and one may even say the duty— of a careful accountant to reduce the value of the result, if he thinks necessary, according to market conditions compared with those upon which the original evaluation has been based. It is, however, the opinion of the author that this second step should be taken separately from the first in order to be able to compare the original value of the stock with that found in the books when closing them at the end of the financial year, and also in order to know exactly to what the actual devaluation amounts.

As already mentioned, there has been developed in the last thirty years another form of stocktaking which may be called *continuous stocktaking* and which avoids completely the drawbacks connected with the usual method, i.e. the stoppage and disturbance of production and the accumulation of surplus work in the office at the beginning of the new financial year. There is, however, one condition which must be fulfilled before the usual form of stocktaking can be replaced by continuous stocktaking—there must be a really first-class organization of stores and accountancy, a fact which will again be checked by the continuous stocktaking. The idea on which this new form is based is that the accounts in the ledgers reflect the actual conditions in the works at any moment; taking that for granted, the checking of the balance of an account by actually weighing, counting, or inspecting the stock can be done at any time and distributed at will over the whole year. A special gang of men under a suitable foreman should be entrusted with this job and the checking can be done according to a carefully prepared plan, which may be kept secret so that the inspection and checking of a stores or department comes unexpectedly to its foreman or departmental manager. The plan should be arranged so that every place in the works is inspected at least once a year, and possibly twice or three times, and any discrepancies between the books and this inspection must forthwith be cleared and the books corrected accordingly.

In order to obtain at the end of the year the figures which are usually given by actual stocktaking, the figures in the books are taken as correct, and experience in works where the new method has been introduced shows that this can be done with sufficient safety. Anyone who has ever been responsible for stocktaking in a large industrial undertaking knows that no absolute correctness can be expected from this work, even if the utmost care is taken. Some mistakes always creep in, and the final uncertainty of the figures will not be less than that of the figures in the books if—to repeat the necessary condition for applying the method of continuous stocktaking—a first-class organization of stores and accountancy exists in the works.

That applies especially to the account of semi-finished goods which is sometimes mentioned as one of the reasons against the method of continuous stocktaking. On the contrary, the author has sometimes found that the accuracy of the new method in regard to this account was greater than the old one. And how much strenuous and time-consuming work could be saved!

Moreover, as modern production tends to limit the "work in progress" to a minimum and has succeeded in this direction to a large extent, a mistake in the balance of this account will not greatly influence the final result.

Another objection made against continuous stocktaking is that it is more expensive than the old method. It is impossible to give a general answer to this statement; it may be true in this or that case, but certainly not always. Besides, it is very difficult to evaluate so exactly in £ s. d. all the advantages offered by the new method that a fair comparison based on money and figures alone is possible. In these circumstances it is recommended that the new method be introduced without discarding the old one, to calculate carefully the costs of both as far as possible, and then to decide which should be applied in future.

The Results of Accountancy

The Balance Sheet and the Profit and Loss Account. Accounts and stocktaking are the two necessary and complementary instruments of accountancy.

The link between them, the combination of the results of the stocktaking and the book-keeping in the accounts, is the Balance Sheet and the Profit and Loss Account. This is not the place to show in detail how these important statements are built up from the accounts; that must be left to the special books on accountancy and is outside of the scope of this work; but the reader should be familiar to some extent with the structure of these statements and should learn "to read a balance sheet," i.e. to understand the meaning of the individual items, their connexion, and how to arrange and compare them with each other so as to obtain a clear and truthful survey of the economic position of the works concerned. For this reason the following explanations may be useful.

The Balance Sheet shows on the right-hand side the assets, i.e. all properties and possessions, and on the left-hand side the liabilities, i.e. the debts and capital. The latter consists of the share capital as well as of the reserves built up in the course of the business. As the Balance Sheet has the form of an account, a profit appears on the left side (under liabilities) and a loss on the right (under assets).

The Profit and Loss Account is a collection of the balances of the individual accounts, i.e. a detailed explanation as to how the profit or loss, as shown in the balance sheet, is composed of various items characterized by the individual accounts.

The Table on page 291 illustrates how the Balance Sheet and the Profit and Loss account can be developed from the accounts of the ledger. The example is intentionally not taken from a modern publication and therefore contains some of the defects which are criticized above. This is of no consequence for the present purpose. The important matters are not the types or names of the accounts and the figures, but the connexions between the various vertical columns of this table.

Columns 1 and 2 with the heading "Gross Balance" show for each account, and for both sides separately, the debit and the credit side, the sums of the figures which have been booked to the account in question during the period for which the balance has to be struck. The addition of both columns gives, according to the rules of booking by double-entry, equal sums, the first proof that the booking has been done correctly from the arithmetical point of view. The next two columns, 3 and 4, under the heading "Net Balance," show similarly for each account the balance which has been found when closing the account at the end of the period for which the Balance Sheet is to be made. Again the addition of both columns gives equal sums, the second proof of correct booking. The figures of the four columns 1 to 4 are now transferred to the columns 5 to 8, recording the liabilities and the capital, i.e. the share capital as well as the reserves, in column 5, the assets in column 6, the profits in column 7, and the losses in column 8. As the sum of column 5 must equal the sum of column 6 and the sum of column 7 that of column 8, the "Net Profit," must be added in the last row

THE RELATION BETWEEN LEDGER ACCOUNTS AND BALANCE SHEET AND PROFIT AND LOSS ACCOUNT.

Accounts	Gross Balance		Net Balance		Balance Sheet		Profit and Loss Account	
	Dr.	*Cr.*	*Dr.*	*Cr.*	Liabilities	Assets	Profit	Loss
No. of column	1	2	3	4	5	6	7	8
	£	£	£	£	£	£	£	£
Capital		100,000		100,000	100,000			
Plant	148,000		148,000			148,000		
Machinery	13,100	50	13,050			13,050		
Equipment	9,300	50	9,250			9,250		
Cash	42,700	42,500	200			200		
Bank	500	5,500		5,000	5,000			
Debtors	97,950	37,500	60,450			60,450		
Creditors	23,500	128,000		104,500	104,500			
Reserves		6,000		6,000	6,000			
Depreciation		13,200		13,200	15,871			2,671
Bad Debts Account	50	800		750	750			
Profit and Loss Account—Balance last year		500		500			500	
Finished Goods	6,500	33,000		26,500		6,000	32,500	
Raw Material	13,000	300	12,700			2,500		10,200
Consumable Stores	1,543	43	1,500			300		1,200
Maintenance Material	750	10	740			125		615
Repairs	1,743	13	1,730					1,730
Discounts	1,100	50	1,050					1,050
Taxes	4,600		4,600					4,600
Interest and Commissions	2,150	1,050	1,100					1,100
Rents and Rates	130	1,800		1,670			1,670	
Salary and Wages	3,800	50	3,750					3,750
Net Profit					7,754			7,754
	370,416	370,416	258,120	258,120	239,875	239,875	34,670	34,670

to columns 5 and 8 as it is the amount by which the sum of the other figures in these columns is less than the sum of all the figures in columns 6 and 7 respectively. A "Net Loss" would of course appear in and have to be added to columns 6 and 7.

The method is so simple that no further explanation seems to be necessary, except as regards a few accounts, where the way in which the figures in columns 5 to 8 are obtained from those in columns 1 to 4 shows some peculiarities. The Depreciation Account has been taken from the previous year at £13,200, but it is inserted as a liability in column 5 at £15,871 and the difference of £2671 as a loss in column 8. This last amount is the increase of depreciation on plant, machinery, and equipment, which was found necessary when considering the condition of these assets in comparison with that at the beginning of the year. A distribution of this depreciation over the year is to be preferred. The figures of the assets of the following four accounts, finished goods, raw material, consumable stores, and maintenance material have been found by actual stocktaking and careful calculation, taking into consideration the market conditions, etc.; the figures of profit and loss on these accounts result by comparing the stocktaking figures in column 6 with those in the columns 3 and 4 of the "Net Balance." The kind of booking on these four accounts shows that they are kept as a mixture of "stock" accounts and "results" accounts, a procedure the defects of which have been explained above. The transformation of the columns 5 and 6, and 7 and 8 respectively into the usual form of the Balance Sheet and the Profit and Loss Account is obvious.

Interpretation of a Balance Sheet. Some hints may be useful on how to read a Balance Sheet, i.e. how to draw from the figures of a Balance Sheet conclusions regarding the economic state of affairs of the industrial undertaking concerned.

These hints can be only a guide to such a study; the actual procedure can be understood best from examples in practice, where the figures of the Balance Sheet relate to matters and facts within the readers' experiences, so that they are not mere abstractions, devoid of reality.

One other preliminary remark is desirable. When reference is made to Balance Sheets and Profit and Loss Accounts, these terms relate only to those internal statements which reflect plainly and openly the true state of affairs, as revealed by a correctly kept ledger. Apart from any fraudulent reason for changing or concealing figures, there are many motives which may lead to summarizing, combining, or even suppressing figures in the published Balance Sheet for reasons connected with the legislation on rates and taxes, or regulations of insurance companies, etc. None of these kinds of balance sheets is taken into account.

Diverse arrangement of the figures of the Balance Sheet. A Balance Sheet has always to be adapted to the special circumstances of the works to which it refers. It is therefore not possible to give a pattern which is generally applicable. Nevertheless a scheme has been represented below in order to facilitate the explanation of the hints mentioned above. It is so arranged as to cover at least a large proportion of the usual kinds of Balance Sheet, thus contributing to greater familiarity with the generally used wording.

For a clear preliminary survey it is recommended that on the left side of the Balance Sheet the nominal capital (ordinary shares and preference shares, assuming the concern is a joint-stock company), and the reserves of various kinds, including, for example, a welfare and pensions fund, should be strictly separated from the liabilities, which should be divided into long-term and short-term debts. On the right-hand side the assets may similarly be divided into works property and neutral property. The latter consists of all property in the hands of the company, not used directly for the purposes of its business, but held in reserve for future development, e.g. estates and

USUAL SEQUENCE OF ITEMS OF A BALANCE SHEET

LIABILITIES	ASSETS
Nominal Capital—	Fixed Works Property—
Nominal capital (ordinary shares, preference shares)	1. Estates
	2. Buildings
	3. Machinery
	4. Equipment
Reserves—	5. Tools and implements
Reserves of various kinds (legal, free, special; del credere, guarantee).	6. Patterns
Welfare and pensions fund	7. Patents
	Floating Works Property—
Long-term Debts—	8. Material
Mortgage debts	9. Semi-finished products
Loan debts	10. Finished goods in the works
Debentures, bonds	11. Finished goods in consignment stores
Workmen's savings	12. Banking credit
	13. Claims founded on bills of exchange
Short-term Debts—	
Bank debts	14. Cash, cheques, postal orders
Debts founded on bills of exchange	15. Trade debtors
Trade creditors	Neutral Property—
Instalments received	16. Estates not used for the works
	17. Participation in other companies
	18. Securities
	19. Mortgage claims

buildings bought for later enlargement of the works, temporary investments of capital in excess of requirements, shares of other companies, securities, etc.

The separation of these figures relating to neutral property, and generally of all results of such neutral business, from transactions arising from the ordinary purposes of the undertaking and usually set out in the Memorandum of Association of the company, is very useful and contributes considerably to a clear survey of the business affairs.

The works property should again be divided into fixed assets and floating assets.

The usual sequence of the individual items of a Balance Sheet as given on page 293 should, however, be changed as illustrated below. There the assets are arranged according to their realizability, or as it is usually expressed, their "liquidity," and the liabilities according to their urgency. By comparing, for example, the floating assets with the short-term debts, or generally assets and liabilities according to their liquidity, valuable conclusions can be drawn about the economic status of an industrial undertaking.

SEQUENCE OF ITEMS OF A BALANCE SHEET ACCORDING TO URGENCY AND LIQUIDITY RESPECTIVELY

(The numbers on the assets side show the sequence of the assets on page 293)

LIABILITIES	ASSETS
(According to urgency)	(According to liquidity)
Instalments received	14. Cash, cheques, postal orders
Debts founded on bills of exchange	13. Claims founded on bills of exchange
Trade creditors	12. Banking credit
	18. Securities
Workmen's savings	19. Mortgage claims
Bank debts	15. Trade debtors
Loan debts	8. Material
Mortgage debts	10. Finished goods in the works
	11. Finished goods in consignment stores
Welfare and pensions fund	
Reserves of various kinds (legal, free, special)	9. Semi-finished products
	7. Patents
Debentures, bonds	3. Machinery
Nominal capital	
Reserves (del credere, guarantee)	5. Tools and implements
	4. Equipment
	6. Patterns
	1. Works estates
	2. Works buildings
	16. Estates not used for the works
	17. Participation in other companies

Management Ratios. Another good test in criticizing a Balance Sheet is to compare the ratio of various items on the same or both sides of the Balance Sheet with the corresponding figures usual in works in the same branch of industry. In this connexion the following statistics may be of interest. The figures are taken from a publication nearly twenty years old, but comparison with some individual, more modern, figures of American origin show relatively small differences. It is not the figures themselves that are of importance but the idea behind them. If any trend of development during the last years can be observed, it is that the fixed assets are growing in proportion to the floating assets; this is certainly due to the greater mechanization of the works on the one hand, and, on the other, to the modern tendency to keep the stocks small and the actual work in constant flow.

	Iron and Steel Works	Textile Factories	Mechanical Engineering Works	Electrical Machines Manufacturing
	Per cent	Per cent	Per cent	Per cent
Liabilities				
Nominal Capital	46	55	51	32
Reserves	5	20	6	9
Short-term Debts	37	2	8	24
Long-term Debts	12	23	35	35
	100	100	100	100
Assets				
Fixed Works Property	58	39	35	16
Floating Works Property	27	52	62	61
Neutral Property	15	9	3	23
Total	100	100	100	100

It is obvious that the ratio "fixed assets to floating assets" determines to a great extent the business policy, e.g. in an industry such as iron and steel, where an unusually large part of the invested capital must be used for the plant, special attention is necessary to ensure that this ratio does not increase to a dangerous extent. Further, great care should be taken as regards expert maintenance and the provision of sufficient reserves for replacement of out-of-date machinery and equipment; for in this industry these items play a more important role in the costs than in other industries; they can be kept comparatively low in the long run only if they are continuously and carefully controlled from the start by experts.

There are other such ratios, which are worth while noticing, From the well-known *Management Handbook*[1] only the following examples can be mentioned, together with the figures for iron and steel works, taken from the same source—

	Per cent
Percentage of surplus net profit earned on sales	10·5
Average turnover of total capital employed	50
Average turnover of inventories forming a measure of the rapidity with which stocks of goods are resold and replenished	502
Average turnover of fixed property investment	70

Depreciation. Further information is given by the investigation of the Depreciation Account. Intimate knowledge of the internal working conditions as well as of the market and its probable development is necessary when checking whether the figures of depreciation are too low, sufficient, or exaggerated. In the last case, which is often intentional, there is concealed in the figure of depreciation a reserve which would be better shown separately in a special account.

Limits of the Balance Sheet as an Economic Guide. So much for the interpretation of the Balance Sheet; but it may not be superfluous to repeat that the hints and the figures given in this connexion are only examples to show how an expert can learn something about the state of affairs in an industrial undertaking from its Balance Sheet.

Further, it should not be overlooked that a Balance Sheet is to some extent only the picture of a moment, i.e. the end of a business year, and that the real trend of development—which is usually more important than such a "snapshot"—can be discovered only by comparing a consecutive series of monthly or yearly Balance Sheets.

Finally, there are "imponderables" in each industrial undertaking such as market conditions, goodwill, tradition, *esprit de corps*, etc., which cannot be expressed in terms of money and therefore do not appear in the Balance Sheet, but which may nevertheless form valuable assets or dangerous liabilities. They should be the subject of the report accompanying the Balance Sheet and cannot be dealt with by the responsible accountant alone. Here the close co-operation of all executives—general manager, commercial manager, works manager, secretary, etc.—is necessary, or it may be preferred to seek the opinion of an independent management consultant.

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[1] L. P. Alford, The Ronald Press Company, New York.

CHAPTER XXVIII

WORKS ACCOUNTS

THE subject of the following discussions is: the analysis, allocation and collection of costs, taken from the different accounts where they are summarized, in order to obtain a basis for—

(1) Controlling the cost of production.

(2) Developing a method of finding the costs of each works order carried out in production, i.e. job accounts.

Accounts, Centres of Costs, Works Orders

It must be understood that all the costs arising in an industrial concern can be analysed as follows—

(1) Costs are a part of an account.

(2) Costs must be allocated to the cost centre, where they arise.

(3) Costs have to be charged to the works order, from the production of which they originate.

Only the term "cost centre" is still unfamiliar to the reader and needs an explanation. All works are divided into departments, which may be either technical, commercial or administrative. As an example of a technical department take production, which may be further divided into main, supplementary, and auxiliary departments. Some of these departments can be considered directly as cost centres, but others need further subdivision; for generally a cost centre should include only similar activities or at least activities similar enough to be considered as a unit from the point of view of costs. For example, a forge may be one cost centre if machines of nearly the same type and size only are used and almost the same type of work is done throughout the shop; but if hammers of various sizes are in use as well as hand-forging, it may be necessary to have one very big hammer forming one cost centre, a group of hammers of medium size a second, the remaining small hammers a third, and the handwork a fourth cost centre. It must be left to the judgment of the responsible man how far the subdivision is carried. To make the decision requires a reasonable knowledge of the production processes as well as an understanding of economics; for subdivision carried too far makes a lot of unnecessary work, and if too many different activities are included in a cost centre the result is unreliable. This very important point is not always given proper consideration in practice. The decision is often left to a subordinate member of the costing department staff, whereas it should be a matter for discussion between the accountant and the departmental manager in question.

The above classification, under these headings, of all the costs arising in a works over a definite length of time is very instructive, as it demonstrates the close connexion between the functions of accountancy and costing and shows that such seemingly different matters as accountancy, works accounts and job accounts, are really only different arrangements of the same figures. The whole body of the costs can be imagined as a cube with the three sides *x*, *y*, and *z*, cut either parallel to *x*, or to *y* or to *z*, representing the cost centres, the accounts and the works orders respectively. (See Fig. 25.)

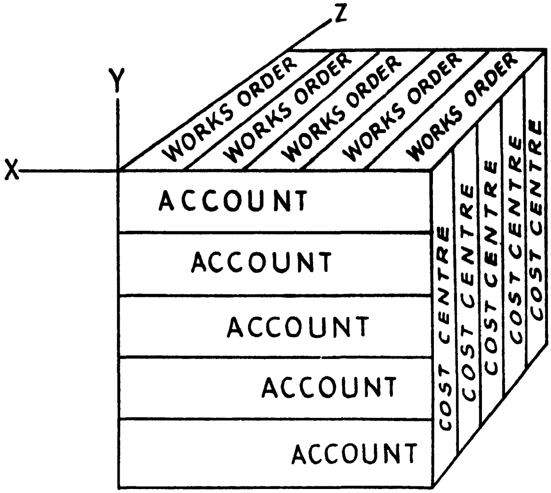

FIG. 25. THE BODY OF COSTS

Since the accounts contain the total costs without exception, their accuracy being guaranteed by the double-entry method, all that is necessary is to take the final figures of the accounts as the starting point for the allocation of costs to the cost centres; and as the correctness of the total figures in the accounts is certain and costing is, by its nature, an approximate method, the allocation to the cost centres can be done by a statistical method which is simpler and therefore more economical than the double-entry method.

There is also another point worth consideration: the above discussion shows the intimate connexion between accountancy and costing. This may seem so obvious as to be superfluous or even ridiculous to mention. Yet how often does it happen in practice that instead of close co-operation as the consequence of this connexion, antagonism, and secretiveness prevail between the two functions.

Before it is possible to discuss in detail how to distribute the costs as collected in the accounts to the various cost centres, two main types of costs must be recognized which results in the subdivision of some accounts into, first, *direct* or *individual costs*, and second, into *indirect* or *general costs*. The first are all costs which can be freely and easily attributed to the works orders, for the finishing of which they have been incurred. The second include all those costs which cannot be accurately attributed to the works orders and they are often expressed as a percentage of the direct costs and known under the term "overheads." Although it should be, in the interest of accuracy, the endeavour of the accountant to increase the first of these two groups as much as possible in comparison with the second, it is desirable to emphasize the expression "freely and easily." It is often found in practice that the desire to be accurate leads to exaggerations which cause unnecessary and uneconomical clerical work without actually increasing the final degree of accuracy. This may be illustrated by an example.

It is usual to allocate the costs of special drawings to the products represented by the drawings. In order to be able to do this the number of hours taken in the Drawing Office to make these drawings is recorded and this figure is multiplied by the average cost of a working hour in the Drawing Office. This gives a high degree of accuracy; but there are people who are not satisfied with this calculation because the salaries of the draughtsmen may be different and the costs of the working hours in the office vary correspondingly. They therefore insist on allocating the "correct" salary to the drawing in question, thus not only increasing the clerical work, but also making the basis of their calculation depend on a more or less casual distribution of the work in the Drawing Office. Thus the first-mentioned average method is not only easier, but even better from the point of view of costing, apart from the fact that the "inaccuracy" thus incurred is certainly within the limits of accuracy of the whole calculation of costs. Analogous cases can be found frequently; one need only mention the work of the Test House, Inspection Department, Internal Traffic, etc. Such over-elaboration draws attention away from the main subject to incidental matters, not worth such a scrutiny.

It is clear that by the division into direct and indirect or individual and general costs some accounts or types of costs must be subdivided, especially the Wages and the Raw Materials Accounts.

It is the duty of the Wages Office to do this job for the Wages Account, i.e. to divide the total sum of wages of a certain period, perhaps a week, into direct and indirect wages and to allocate each part to the various cost centres where they have occurred. In a similar manner the Stores Control Office has to deal with the Raw Material Account, and the Consumable Stores Account. It has already been described how Wages and Stores Control Offices can do these jobs and the means of simplification and mechanization by which the collection, distribution and allocation of the innumerable vouchers can be facilitated have been discussed. Here it may only be repeated that the importance of these original vouchers for production control and costing purposes is, oddly enough, often underestimated; they are not made out with the necessary care and accuracy and hence the results drawn from these figures are likewise not reliable. The production man, departmental manager or foreman or workman, should do all in his power to improve matters in this respect.

Besides direct wages and direct material costs there may be other costs which can be considered as direct costs, e.g. the supply of special equipment from other suppliers which will form part of the final delivery, or special patterns or jigs which can be used only for certain works orders, etc.

All these direct costs have to be dealt with separately and their distribution over the cost centres is obviously indicated directly by the corresponding vouchers. Nevertheless the remark to be found in many publications on costing, to the effect that dealing with direct costs is so simple that no further explanation seems to be necessary, is not justified. This is true only in principle; but everybody who has had to do this work in practice knows the many difficulties which arise and the great care necessary to overcome them. To describe the allocation of direct costs as "simple" without further qualification is liable to give the inexperienced the wrong impression.

Another kind of difficulty must be overcome if the indirect or general costs are to be allocated to the various cost centres. As the name indicates, there is no direct connexion with the works orders which are carried out in the various cost centres. For some accounts, as, for example, Consumable Stores, it may be clear from the vouchers to which cost centre the stores have been issued; but there are other accounts where no such connexion exists and a means must be found of distributing the costs of materials. The usual method is to establish a unit cost by dividing the total cost of the materials or services over a given period by the total number of units used or consumed throughout the factory. For example, the total cost of providing electric power to the factory is known as well as the total number of kilowatt-hours (units of electricity) supplied. Therefore to find out how much of the cost of supplying electricity should be allocated to each cost centre, it is only necessary to measure the kilowatt-hours consumed by each cost centre. In the same way costs of lighting, rents, rates, etc., might be allocated to the cost centres on the basis of costs per unit of area occupied by the cost centres; costs of heating and ventilating by the cost per unit of volume; depreciation of plant and machines on a time basis and so on. In many cases no obvious unit of measurement exists, but it is usually possible to find some unit which will give an approximation and, if this fails, then any method which will give a reasonable result must be used.

Management and supervision can usually be booked to the cost centre where they are incurred, but if they have to be spread over a number of cost centres some convenient basis must again be found.

It should be remarked that it is the necessity of making these constant approximations in the distribution of costs which renders all costing to a certain extent a matter of judgment rather than of strict mathematical accuracy.

The results of this first distribution of costs to all cost centres give the main basis of "production control" as part of economic control. Cost centres are usually selected to correspond with the responsibilities of certain persons, departmental managers, assistant managers, foremen, charge hands, etc. No other costs, which can be considered more or less outside their direct control, are included in this first distribution of costs and it is only fair to take these figures alone when judging the activity of managers and supervisors from the cost figures. Costs for which they are only partly responsible but which will eventually have to be allocated to the cost centres are best omitted at this stage, as other responsibilities are involved which often veil the final results in such a manner that it is difficult, if not impossible, to do justice to the manager or supervisor in question. This should be avoided in all circumstances, as such procedure easily tends to sow mistrust between the production man and the accountant.

But even if the results of this first distribution of costs to cost centres are alone taken into account, judgment of the efficiency of executives is no easy job and the utmost care should be taken when drawing conclusions. One point especially needs consideration:

the working conditions are very seldom so similar in two cost centres that comparison between them is possible, even if they seem to be at first glance of the same character. If this is so in the same works, how much more is it the case when the two cost centres belong to two different works. It is therefore seldom possible to transfer figures obtained in one works to another. This remark should not be misunderstood; the value of experience obtained in other similar jobs is not under-rated, but the above consideration should lead to the conclusion that the best kind of comparison is the observation of development in one and the same cost centre.

An example taken from mechanical engineering may be quoted which indicates the difficulty of comparing two seemingly equal cost centres; a special machine tool was producing a certain workpiece in a large mass-production works. Piece-work prices were established to the satisfaction of management and men. It so happened that exactly the same workpiece was later needed in another part of the works and, as the output of one machine tool was then insufficient, it was decided to install a second machine of exactly the same kind. It was installed in that part of the works where the increased demand for these workpieces had arisen. But in spite of all the trouble which the management took, and the good will of the men, they were not able to earn their money on the same piece-work prices. It took a long time before the reason was found: the first machine was installed on the ground floor and the second on the third floor of their buildings, respectively. The greater vibration of the second machine prevented it obtaining the same results as the first in the same working time.

Because of the necessity of continuously observing the development of the figures of the same cost centre, the Cost Department should show these figures in the form of tables or graphs which can be added to week by week, or month by month.

The second purpose of collection, distribution and allocation of costs to the cost centre is to establish a basis for the job accounts. For this reason a further distribution and allocation of the costs incurred in the auxiliary cost centres must be made to the main and supplementary cost centres, because only these—sometimes called "final cost centres"—have direct relationship to the goods produced. This allocation is usually done in two or more steps, as some intermediate results may be of interest. For example, the toolroom needs electric power for its machines; it is important to know the total costs of the toolroom, including these power costs, in order to be able to compare in a fair manner the costs of production of a certain tool when made in the shop and when bought outside. (See Fig. 26.)[1]

LIST 1. KEYS USED FOR THE EXAMPLE ILLUSTRATED BY FIG. 26

No. of Keys	Derived from
6	Output and Efficiency respectively
4	Numbers of Workers
4	Numbers of Staff Members
3	Numbers of Workers and Staff Members
4	Numbers of Machines
3	Size of Areas
1	Number of Standard Candles
1	Number of Telephone Connections
1	Values in Fire Insurance Policy
1	Prime Costs of Plant
1	Value of Stocks (Raw Material + Finished Goods)
5	Keys are arbitrary experience rates (these keys should be avoided as far as possible)
34	Total Number of Keys Used

LIST 2. COST CENTRES USED IN THE EXAMPLE ILLUSTRATED BY FIG. 26

Final Cost Centres

No.	Name
1.	Stores of Materials
2.	Sawing and Cutting-off Shop
3.	Forge
4.	Annealing Shop
5.	Turning Shop
6.	Milling and Planing Shop
7.	Drilling Shop
8.	Hardening Shop
9.	Grinding Shop
10.	Fitting Shop
11.	Assembly
12.	Test Room
13.	Sales Department

Cost Centres of the 1st Stage

No.	Name
29.	General Adminisatrtion
30.	Financial Book-keeping, Cashier
31.	Filing, Post
32.	Wage Office, Calculation, etc.
33.	Design and Drawing Office
34.	Stores of Office Material

Cost Centres of the 2nd Stage

No.	Name
26.	Works Management
27.	Planning Department
28.	Welfare Department

Cost Centres of the 3rd Stage

No.	Name
14.	Internal Transport and Loading
15.	Carriages (Autos and Lorries)
16.	Toolroom
17.	Joiners' Shop
18.	Experimental Shop
19.	Maintenance Shop
20.	Electricians
21.	Waterworks
22.	Power Station
23.	Boiler House
24.	Purchasing Department
25.	Administration of Material

During a particular month the result of the investigation with regard to overheads in the example quoted by Fig. 26 was as follows—

Final Positions or Centre of Costs	Percentage
1. Indirect Material Costs	19 per cent of Direct Material Costs
2. Sawing and Cutting-off Shop	135 per cent of Direct Wages
3. Forge	176 ,, ,, ,, ,,
4. Annealing Shop	254 ,, ,, ,, ,,
5. Turning Shop	231 ,, ,, ,, ,,
6. Milling and Planing Shop	268 ,, ,, ,, ,,
7. Drilling Shop	258 ,, ,, ,, ,,
8. Hardening Shop	107 ,, ,, ,, ,,
9. Grinding Shop	157 ,, ,, ,, ,,
10. Fitting Shop	248 ,, ,, ,, ,,
11. Assembly	139 ,, ,, ,, ,,
12. Test Room	100 ,, ,, ,, ,,
13. Sales and Distribution Costs	13 ,, ,, Production Costs

These figures should *not* be regarded as representative, but *only* as an example in a particular case.

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[1] It should be understood that this Fig. 26 is only a "made-up" example, i.e. it is greatly simplified and abbreviated in comparison with examples derived from real practice, as it is the only purpose of this discussion to introduce the reader to the principal ideas involved. For more detail, examples taken from real practice should be studied, as for instance the papers of C. Holzel in *The Accountant*, 18th October, 1941, and *The Cost Accountant*, 7th August, 1943, and 12th August, 1944.

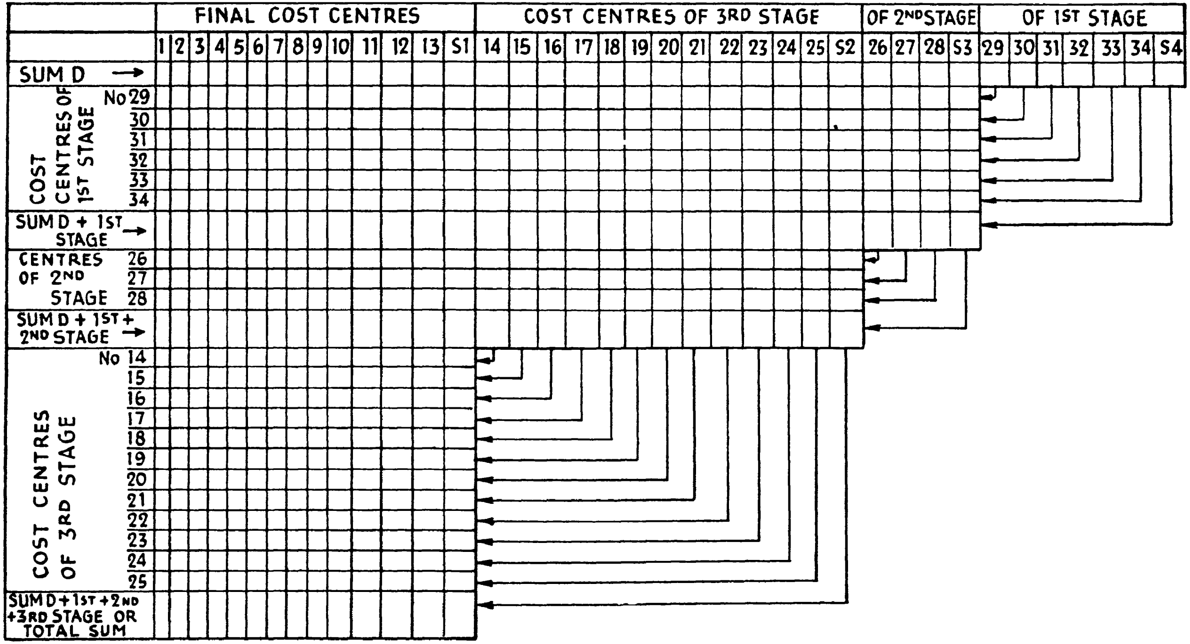

FIG. 26. EXAMPLE OF AN ALLOCATION OF INDIRECT OR GENERAL COSTS DISTRIBUTED TO COST CENTRES OF A MACHINE FACTORY OF MEDIUM SIZE

Sum D = sums of indirect or general costs distributed from the accounts to the centres of costs.

Nos. of the cost centres coincide with those of List 2.

Columns $S1$, $S2$, $S3$, and $S4$ are used for horizontal and vertical summarizing in order to prove that no writing errors or addition mistakes have occurred.

The Allocation takes place as far as possible directly, i.e. based on vouchers originating in the works; where that is impossible, according to suitable keys (see List 1).

Again there is the difficulty when carrying out this second allocation of finding the best basis: again it must be emphasized that that basis should be used which forms the nearest approach to the actual procedure without increasing unduly the clerical work. Thus, for example, the costs of the Maintenance Department may be distributed according to the actual work the Maintenance Department is carrying out for the benefit of the individual cost centres. Here, again, exactness can be exaggerated, especially as in some cases only a basis which is to a great extent arbitrary can be used. For example, to allocate the costs of the Maintenance Department on the basis of the direct wages it spends for the benefit of the main cost centres is sometimes arbitrary, but is often used.

Another distinction has to be made between "*real*" and "*calculated*" *indirect costs*.

Real indirect costs are those for which supporting statements such as invoices, stores, requisitions, wage tickets, etc., exist, i.e. statements arising in the usual course of business either inside the works or from outside sources. Calculated indirect costs are costs for which such statements are not forthcoming automatically, and therefore the accountant has to calculate them and provide vouchers for them so that they can be included in the total costs of the products.

The most important of these calculated indirect costs is what is usually called *depreciation*. No problem in the theory of industrial accounts has been so extensively discussed as that of depreciation and it might be thought that by now everything would be clear and common agreement arrived at. But there is still considerable difference of opinion on this very question of how to deal with depreciation in the costing system.

This is not the place to discuss the problems concerned in detail, nor does the author feel entitled to decide between the various contending theories put forward, but it is hoped that the following statements represent what is considered at present as good practice—

(1) "Depreciation" in the sense of compensation for wear and tear and obsolescence is different from "depreciation" as often used in published balance sheets, i.e. an item containing secret reserves. If both meanings are used in the same concern some way of recognizing which is meant should be introduced to avoid confusion in the industrial accounts.

The following points (2) to (9) refer only to depreciation for wear and tear and obsolescence.

(2) It is all the same whether depreciation is based on the prime

costs or on the book value of the plant, because neither method can be claimed as absolutely correct, i.e. as always giving the actual value of the plant in question during its life-time. The first method is perhaps preferable because it is simpler and gives greater stability to the cost figures.

(3) Different percentages of the basic values should be used for the two methods mentioned under (2) so as to obtain similar end values at the same moment.

(4) These percentages are different for different kinds of items, and can be estimated only from experience or may be taken from handbooks if such experience is not yet available in the works in question. The figures must be checked continuously, i.e. at least once a year in accordance with experience gained in the meantime, and the necessary corrections must be made in costing as well as accountancy.

(5) The determination of percentages for depreciation is by no means an easy task which can be done mechanically, say in accordance with some general rules drawn up by the management. On the contrary, the working conditions and the state of repair of every single item of the plant must be carefully taken into account, and that can be done only with the assistance of experts, who are moreover familiar with the special circumstances of the works. Thus it will usually be the best solution if this work is done by close co-operation between the departmental manager, the maintenance engineer and the accountant.

(6) Depreciation has to be taken into account as part of costs in calculating a job, carried out with the machinery in question. The suggestion that no depreciation need be included in costs, if such machinery has already been "fully depreciated," must be considered wrong; for in such cases either the originally used percentage was too high or the machinery is still working in spite of being obsolete. In the second case sound technical progress would be stopped; for under such a method of costing the calculation could rarely show that a new plant would be as cheap to run as the old one, i.e. the old plant would never be replaced "for economic reasons."

(7) Depreciation figures should be shown on a special account, which must be carefully watched, so that it is always a true picture of the capital originally invested in the works minus that part of the capital which has already been transformed into products by the use of the machinery.

(8) The actual substitution of new machines for old ones must be charged to this account, except in so far as a machine is replaced by one of higher capacity. In this case the difference between the

price of the new machine and the price of one of a capacity of the replaced machine must be charged to a rebuilding and improvement account.

(9) While the basis of the whole calculation is a matter of estimation, i.e. must always remain, even if treated very carefully, an approximation subject to inaccuracies, the details are afterwards often worked out with the accuracy necessary in accountancy. This results in the belief that the final figures are more reliable than the method by which they are obtained allows.

The second kind of "calculated" indirect costs is *interest*, or at least that part of this type of costs not actually paid to a creditor, but which could be calculated as imaginary debts to the original owner of the invested capital. Again there are divergent opinions on how to deal with this item and again there is no need to go into the detail of this dispute.

The author can only express his own opinion that interest on a concern's own capital is and remains part of the profit in accordance with common sense as well as with the rules of accountancy; those who wish to include it in the calculation of costs for practical reasons may do so; but they should then always remember, when, for example, fixing the necessary selling price of a finished product, that the profit they calculate represents not the total gross profit, but will finally be increased by the amount of the calculated interest which they have included in their costs.

Finally it may be added that the best rate to choose for calculating interest on the capital invested in plant, machinery, equipment, etc., is the rate ruling for long-term debts, whilst for that part of the capital which is represented by raw and auxiliary materials and semi-finished and finished products the rate should be that for short-term debts.

Other "calculated" indirect costs which may be mentioned are *employer's drawings*. This type of cost has only to be taken into consideration in the case of privately-owned works. It is understood that what an employer draws from the works, of which he is the owner, is composed of the recompense for the actual work of management he is doing and the profit he obtains from his invested capital. The first part, assumed to be about the amount of the salary of a general manager in a similar concern (perhaps a joint-stock company), is considered as a part of the costs. Only if this is done, is a fair comparison of the costs in a privately-owned concern and in a joint-stock company possible. On the other hand it may be said that it is just this difference which should be reflected in the costs, and that the employer may draw in times of slack business less than the calculated salary. In this case should this difference be treated as a debt owed by the concern to the owner? These may be the considerations why employers' drawings are generally not included in the costs of British concerns, in opposition to the continental custom.

Another kind of "calculated" indirect costs referred to above includes *risks of any kind* which are not covered by insurance, which usually covers such risks as the damage caused by fire, flood, robbery, etc. In any business other risks arise from causes which cannot be foreseen or whose effects cannot be calculated; perishing of raw materials or finished goods; breakdown of plant; unexpected repairs to or replacements of finished goods, where the costs for some reason cannot be recovered from the customer; curtailment of profits by suspension of payment; penalties for not correctly fulfilling contracts, etc.; and finally the general risk of any employer arising from failure of design, change in customers' tastes, fluctuations in economic conditions, etc. It is very difficult to estimate the correct amount which should be included in the costs for these risks. This may be the main reason why very often no such provision is made in the costs and it is preferred to try to build up a reserve to cover such losses if and when they occur.

Summarizing, it can be said that it must be left to the discretion of the responsible man whether he prefers to include "calculated" interest, employers' drawings, or risks in the costs, or to cover them from the Profit and Loss account. In practice there is scarcely a difference; for it amounts to the same whether the calculated costs are lower and a higher addition for profit is made, in order to get a certain net profit, or vice versa. In spite of that these discussions on "calculated indirect costs" do not seem to be without value as they show how many items should be taken into consideration when building up a costing system in an industrial concern. The fact that often the decision must be left to the discretion of the responsible man in each individual case cannot be altered as long as no authoritative national body has given a standard guide, accepted by industry. But even such a convinced advocate of reasonable standardization as the author of this book doubts very much whether accountancy and costing should be made the subjects of standardization to any large extent. Both should reflect the organization and the economic state of the industrial concern as truly as possible, and as each such concern is individual with its own peculiarities, standardization pushed too far would be a contradiction in itself. This may make it more difficult for the accountant, but on the other hand it makes his job so much more attractive, if only he is the right man for it.

Various Types of Costing Systems

There are different forms of cost calculations and the choice of the form depends on the nature of the work carried out in the cost centre or workshop in question, and also on the purpose of the calculation.

Where only one single product or operation is produced in equal units the calculation is very simple: the total costs in a given period, e.g. a month, are divided by the number of units produced; therefore this method is termed "division costing."

It is more difficult if the products or operations of a shop are different and therefore the costs of the shop must be subdivided and allocated to these different products. In this case some costs can be distributed directly to the works orders concerning each product or operation; in the others the indirect or general costs cannot be so distributed and must be covered by additions to the direct costs, usually a percentage addition which in this form is generally known as "overheads." This method is known as "addition costing."

Addition costing can again be divided into two different kinds of calculation according to the amount of difference which exists between the works orders. If this difference is very frequent and is such that one works order is usually different from the other, each has to be dealt with as a single item to which costs must be allocated; in this case an order must be given out indicating exactly the nature and the amount of the individual item, and this order is the basis for cost allocation. That is the reason why this kind of calculation is termed "order costing."

If, on the other hand, there is only a limited number of products being produced repeatedly from time to time, the basis will no longer be an order strictly indicating the nature and amount of the product, but the order will give only the approximate amount and determine merely the time during which this special class of product should be produced, leaving it to the workshop to decide how much can really be finished in that time. This may be called "class costing."

Obviously "order costing" and "class costing" are both "addition costing," but the works orders are limited differently. In the first case the quantity of the products, and in the second the working time, is given as the limit. As "class costing" is simpler than "order costing," an endeavour should be made to substitute "class" for "order" costing wherever possible, for example at rolling mills, when *jobbing* work is not the only kind of work, but stock orders are possible at least to some extent. In other cases, however, this is scarcely practicable, as for instance in the Maintenance Department.

A further simplification of the class costing system can be obtained by introducing "equivalent figures." They correlate the different costs per unit of the various classes to the costs of one of them, which is selected as the basic class; it is possible with the help of these equivalent figures to reduce the total output of a department, say for a week, composed of several classes, to an equivalent output of the basic class, and as soon as this is obtained the problem of costing is obviously reduced to the most simple case, that of division costing. Of course there must be taken into account the work necessary to determine the equivalent figures, and in the selection of the method consideration must be given as to which class entails the minimum of work. It should not be overlooked that in normal times the variation of equivalent figures will be only small, so that these figures need be verified only at long intervals.

It must be left in each individual case to the discretion of the responsible person how far the subdivision into classes shall go, or whether it is not possible to include similar classes in one common group as a single class. It should always be remembered that costing cannot be more than an approximate calculation and that exaggerated subdivision will increase the clerical work unduly. On the other hand, the grouping together of different classes always gives an average value, which depends not only on the individual values, but also on the ratio between the various classes; and how important this can be is shown by the following example—

A group may be composed of two clases *a* and *b*:

1st month:	40 *a* @ £5	= £200
	60 *b* @ £4	= £240
Average	100 @ £4 8s.	= £440
2nd month:	80 *a* @ £4 15s.	= £380
	20 *b* @ £3 18s.	= £78
Average	100 @ £4 11s. 7d.	= £458

Although both classes have become cheaper, the average has increased, solely because the ratio of quantities has changed.

After this fundamental consideration of the various types of costing systems it may be useful to give some examples of how these ideas operate in practice. Obviously it depends mainly on the kind of product made and/or of technical process carried out in the department or cost centre.

It is more useful to choose as examples the auxiliary departments which show more similarity in the various industries than main or supplementary departments which have a much greater variety.

Plants for the production of steam, electricity, and compressed air, for the supply of water and the like, are clearly suitable for division costing, but for the Maintenance Shop, the Traffic Department and Test House, the General Works Service, etc., more complicated methods have to be used.

The General Works Service may consist of the porter at the works gates, day and night watchmen in the works and offices, the fire brigade, sanitary and ambulance stations, etc.

The costing of the work done by the Maintenance Department is more difficult, as their work is so different and varied. Sometimes the working hours or the wages paid are used as the basis of costing, but they both have defects for this purpose, as the value of one working hour may not be equal to that of another and this inequality may be even worse when attempting to cost the wages paid per unit of work done. It must be decided in the individual case, whether this inaccuracy can be tolerated or should be reduced by dividing the Maintenance Departments into a number of cost centres. It is usual to form at least three such centres: (*a*) work outside the shops, (*b*) work in the shops on the machines, and (*c*) hand work in the shops, and then to subdivide (*a*) and (*c*) according to the various trades, such as fitters, turners, electricians, plumbers, bricklayers, etc., and (*b*) according to the kind of machines used, as lathes, drilling machines, shears, etc. Each of these cost centres uses as measurements the working hour or direct wages as a cost basis, counting as such only those wages actually paid for maintenance work for other shops. Indirect costs are in this case the wages of the foreman and the wages of the auxiliary workmen in the cost centre, which cannot be attributed directly to the operation. In other words: in this case the meaning of the two terms "direct" and "indirect" must be understood from the workshop angle and not from that of the concern.

Maintenance materials can be allotted to the shops by various methods: they are either charged to the Maintenance Shop, which has to do the work of maintenance, and then transferred together with wages and overheads to the shop for which this work is carried out, or they are charged directly to the latter shop, avoiding the Maintenance Shop completely. Although the second method is, of course, simpler from the point of view of book-keeping, the first one should be preferred, as experience has shown that mistakes are less likely to be made.

Order costing should be applied in the case of maintenance work which is important enough for the costs to be known as a whole, and the Receiving Shop should then be charged with this sum. Sometimes maintenance work is entirely dealt with in this last and certainly very correct manner, even for less important work. This procedure involves the danger of an unduly increased clerical apparatus.

The Internal Traffic Department comprises all transport from shop to shop within the works, but not in the shops themselves. It is not easy to find the correct measure of the performance of this department. Each kind of transport, e.g. by locomotives, cranes, motor trucks, etc., has to be treated as a separate cost centre. The weight of the transported material is often used as a measure within such a cost centre. It is obvious that that is not correct, as the distance travelled must have some effect. Therefore the "ton-mile" has been used in works of great area; but it is questionable whether the improvement in accuracy is great enough to counterbalance the work connected with the refinement of the method; for as simple considerations about loading and unloading show, the "ton-mile" measure is also not correct. A third method is to develop a regular transport tariff based on special investigations such as method and time studies and to verify the correctness of this tariff by comparing the total amounts thus calculated with the total transport costs. This way is undoubtedly the best one, but also causes the most work; it would pay only under fairly stable working conditions, so that no frequent additional investigations and changes of the tariff were necessary.

The measures of the outputs of the various auxiliary departments should form the basis for allocating the costs of these departments to the main and supplementary departments; frequently, however, auxiliary departments work for each other, and in this case the bill between them must be settled first. This may sometimes be difficult, as the mutual charges cannot be calculated properly before the costing result of both is known for the period in question. Although it is possible to find a mathematically correct solution for this problem, it is usually ignored as being too complicated and a method is used which may contain an error, but one of no significance in the final result. This method is best illustrated by an example.

Electricity is necessary for steam production and steam for the production of electricity. Both are produced by their own power station. Before the mutual charging of one cost centre to the other, the following figures could be obtained—

	Steam	*Electricity*
Total production	10,000 tons	500,000 kWh
Various costs	£1750	£150
Supplied to electricity	5000 tons	
Supplied to steam		40,000 kWh
i.e. of total production	50 per cent	8 per cent

The further calculation now reads as follows—

Approximate price per ton steam:

$$\frac{£1{,}750}{10{,}000} = 3{\cdot}5\text{s. (assumed to be } 3{\cdot}7\text{s.)}$$

5000 tons × 3·7s. = £925

Cost of steam supplied to electricity .		£925
		£1075
8 per cent of £1075	£86	
	£1836	
	3·672s. per ton	
Costs per unit (about): 3s. 8d. per ton;		0·516d. per kWh

The difference between the assumed and the calculated unit price of steam/ton is negligible.

The allocation of the electricity and steam costs now seems to be very simple, and that really is the case, if the actual amount consumed by receiving shops or cost centres is known. Unfortunately this is not always the case because the installation of meters is regarded as too expensive. If this is sometimes so for steam consumption, it cannot be accepted as justified for electricity, where reliable and non-complicated measuring instruments are on the market. It will be found that the sum of the consumed units is always somewhat smaller than those produced and the author remembers a case where the installation of meters before the various cost centres—allowed only after a long struggle with the financial management—quickly brought about the discovery of transmission losses so great that the prime cost of the meters was saved in a very short time.

After these considerations it can be left to the reader to find out in each case the best way to allocate the costs of the auxiliary departments to the main and supplementary departments. It may only be mentioned that for the general works service it is not usually possible to do other than distribute its cost proportionally to the production wages paid in the individual shops or cost centres. It should not be overlooked, however, that this basis does not take into account the degree of mechanization and therefore puts too high charges on the shops with a preponderance of hand work—another example of the repeatedly-mentioned character of costing as an approximate calculation.

Finally this chapter on works accounts may be concluded with a reference to the fact that the various methods described of distributing and allocating costs are by no means limited to the costs arising from production. Similar methods could be used with suitable adaptations for the costs arising from selling and distributing goods.[1] In this sphere also there are accounts, cost centres and works orders; costs could be divided into direct and indirect or individual and general, and they could be distributed and allocated on the same principles and for similar purposes. In studying the publications which deal with these matters, it is frankly surprising that little or no attempt appears to have been made to apply the experience gained in dealing with the costs of production to the costs of selling and distribution, although the problems are identical and their answers are almost the same. Perhaps this is due to the lack of a standardized nomenclature which makes mutual understanding difficult. Or perhaps, as distribution and selling costs are usually considered much smaller than production costs, it is not thought worth while to give them more than the superficial attention which is all they usually receive to-day. This last argument, which may have been correct at some time in the past, will certainly not be justified in the future, when the struggle for markets will undoubtedly become more and more acute.

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[1] See, for instance, *The Problem of Selling and Distribution Cost Accounting*, Institute of Cost and Work Accountants.

CHAPTER XXIX

JOB ACCOUNTS

WHILE Accountancy and Works Accounts are based on time (week, month, year), Job Accounts deal with the output expressed in quantity, units, pieces, etc.

Disregarding for the moment that an order may be started shortly before the end of a month, so that it is partly in the previous month, partly in that under consideration, and that this may be repeatedly similarly at the end of the month, when an order may have to be finished in the following month—an overlapping that can be taken into consideration by certain corrections—the total result of the month can be determined either by Accountancy in the manner previously explained, or the results of all orders carried out during this month and expressed in the form of Job Accounts can be added together. The connexion between Accountancy and Job Accounts is obvious. The result of the summation of Job Accounts during a month can be considered as correct only if it is equal to that obtained by Accountancy for the same month. This equality does not need to be correct to a penny; it is sufficient if the difference between the two results does not exceed, say, 1 per cent of the total amount. This last remark is not superfluous because it is obvious. The author well remembers an ardent and certainly conscientious cost accountant in a large works who worked for days to bring about exact agreement till it was explained to him that the difference of methods in the two branches of industrial accounts made it nearly impossible to obtain precisely equal figures.

General Equation of the Cost of a Job

The connecting link between Accountancy and Job Accounts consists of what has been termed "Works Accounts." They are based, like Accountancy, on time, but apply a statistical method similar to that used when calculating Job Accounts, not the double-entry method of Accountancy. It is possible to develop certain equations for determining costs in industrial concerns based on the figures of Works Accounts and applicable to time as well as output; but the possibility must be kept in mind that the different purposes may require different procedures and even sometimes different figures, in which case care must be taken to balance the differences before a comparison is possible.

A general equation for determining the cost of a job in industrial concerns may read as follows—

Direct material cost, i.e., costs of the raw material contained in the finished products minus any credit for scrap recovered
+ Indirect material cost arising from storage and transport in stores, between stores and workshops and within the area of the works generally
= Total material costs
+ Direct labour cost, i.e. direct wages paid in the final cost centres concerned
+ Indirect labour cost, i.e. expenses incurred by the workshops and the works administration, and allocated to the final cost centres concerned
= Total labour costs
+ Special direct costs, i.e. cost arising for the particular order which can be anticipated with sufficient accuracy.

(Although these special direct costs are composed of the same types of costs as the usual costs it is considered expedient to deal with them separately in order to facilitate comparison with other orders. They are calculated as supplementary orders and then inserted into the main order.) Then—

Total material costs + total labour costs + special direct costs = total production costs.

To these total production costs must be added the costs of selling and distribution, which again may be divided into direct and indirect selling and distribution costs, the latter occurring through the purchase of materials, accessories, etc., and in that part of the administration which concerns the trade or commercial side of the concern.

Finally

The production costs + the selling and distribution costs give the complete total costs.

It is usual to relate the indirect material costs to the direct material by using the weight of the latter as a denominator. This cannot be considered as completely correct; but it is usually considered as sufficiently accurate, although it must of course be granted that it is and remains an approximation. This fact is used sometimes as a reason for adding the indirect material to the indirect labour costs and relating the result to the direct labour costs, usually as a percentage, but this simplification is only slight and the error which is introduced may be considerable, as soon as some job occurs where direct labour costs are small or are not incurred as, for example, when delivering raw material from stores to customers without any further production processes. In this case the share of the indirect costs, according to the simplified calculation, would be equal to nil, whereas it is obvious that storage and transport costs, etc., have arisen. Generally it can be said that because a calculation is only an approximation, it does not justify the choice of a much rougher approximation unless there are great advantages of another kind, e.g. simplification, etc., counterbalancing the loss of accuracy.

Indirect labour costs are related to direct labour costs, and attention has already been drawn to the fact that either the direct costs themselves may be used as denominator, thus making the indirect costs a percentage addition on the direct costs, or the working hours of the men may be used, thus obtaining a figure of costs per working hour.

The indirect selling and distribution costs can be related either to the direct selling and distribution costs or—what is so usual that one may even say it is the rule—can be expressed as a percentage of the production costs.

These general explanations may be illustrated by a numerical example taken from practice in an iron and steel works. See p. 318.

This example contains a column to which particular attention must be drawn, i.e. price per unit. The question of valuation which is answered by this column is again one which shows with special clearness, *the character of cost accounting relative to the purpose for which the calculation has been devised.*

It could be said with only slight exaggeration that different costs could, and should, be developed for each individual purpose. For example, the "book value" is the correct basis for all figures of Accountancy, production statements, etc., but "market prices" should be taken when endeavouring to find an adequate sales price or the profit accruing from a given sales price, and "standard prices," excluding as far as possible all outside influences and internal contingencies, should be preferred for production control, planning, etc. This, of course, is not permissible in practice: the clerical work would be so enormous that the final result would no longer be considered economical; but it is nevertheless good to clear one's mind before deciding on the necessary compromise. Generally, this problem of different valuations for different purposes mainly concerns raw materials. Wages, salaries, and many other expenses do not in most cases need any conversion from one "price" to the other, as the differences are small; consumable stores are mostly of no importance; perhaps only fuel and energy —the latter if obtained from outside—should be taken into consideration besides the raw material. It is usual to choose as a basis the "book value," which has to be taken for Accountancy purposes

	Quantity, tons	Price per ton	Value	Value
		£ s. d.	£	£
Cost of the charge	12,000	4 0 0	48,000	
+ Supplementary costs of the charge		6	300	
	12,000	4 0 6	48,300	
− Credit for scrap	1,500	2 0 0	3,000	
− Credit for scale and slag	500		50	
	2,000		3,050	
= Total material costs	10,000		45,250	45,250
	Hours	Price per hour		
Cost centre 1—				
Direct costs			5,000	
Indirect costs	2,000	6 17 0	13,700	
+ Cost centre 2—				
Direct costs			12,500	
Indirect costs	4,000	4 19 9	19,950	
	Tons	Price per ton		
+ Cost centre 3—				
Direct costs			-	
Indirect costs	10,000	13 8 4	6,850	
Total labour costs			58,000	58,000
Material labour costs			103,250	
Rate of rejects 2 per cent of (material labour costs)			2,065	2,065
Production costs			105,315	105,315
Direct selling and distribution costs			3,900	
+ Indirect selling and distribution costs = 8 per cent of production costs			8,400	
= Selling and distribution costs			12,300	12,300
Total costs				£117,615

in any case and can be used in many other cases, and to convert the figures obtained where necessary in the sense indicated above.

Perhaps it should be added that these considerations hold good only for comparatively quiet times with the usual small fluctuations of market prices. As soon, however, as periods of real inflation or deflation set in, different measures must be taken to follow the course of events as far as that is actually possible, but dealing with these problems is considered outside the scope of this book.

How do the above general reflexions influence evaluation procedure in practice?

It is usual to use the production costs without any profit margin for the evaluation of deliveries and services *from one department to another in the same works.*

The question is only whether this almost universal custom is the only suitable one and whether it fulfils all requirements for which one may reasonably ask? For instance in a big electricity combine and in a large concern in the metal working industry another system has been applied with great success, i.e. "fixed charge prices" based on calculations of production costs and including a fair profit margin, the general manager having the right of correcting these prices as often as he thinks necessary. This system is not recommended for every case, but it has worked very well in the two cases mentioned above, and it is not evident why only the system now in general use should always be applied, especially as it sometimes has disadvantages which outweigh what is rightly regarded as its great advantages—simplicity and clearness. The main disadvantage is that it shows a profit only in the last, the "final," department through which the finished product has to go when manufactured. Of course everyone in the management and in the works knows that this is wrong and that every department has a share in the final profit—if he thinks about it; but unfortunately he very often does not do so and the psychological result is often distressing. There are many who will not concede that this is a reason for a change in costing methods. They may keep to the system they are accustomed to, but experience in practice has taught one to attach more and more importance to these "imponderabilia" and the author is inclined to-day to render the work of the Costing Department more difficult by asking for some conversions, etc., *if* this is a means of giving greater satisfaction to the more ambitious people in the works. It is true that a second difficulty arises if the method of using prices with a profit margin is adopted, as the amount of this margin rests more or less with the general manager, but this disadvantage can be converted into an asset since the decision on the prices to be used gives him an opportunity to show his understanding and impartiality and thus increase his authority among his staff.

For deliveries from outside sources, fixed-charge prices, market prices, and what are sometimes termed cost prices, i.e. prices including transport and other charges which have been paid for the supply of the materials to the works, have been recommended. A fourth price, based on the estimation of the costs which would arise when the material in question was to be bought anew after consumption, is of no importance in normal times and cannot be recommended, as it is always subject to the uncertainty connected with estimation, but it plays a big role in times of inflation.

Fixed-charge prices have the advantage that fluctuations in market prices are eliminated from the Material Accounts. If the finished products of the works are also calculated to fixed prices, the limits of the production are standardized and any changes in the production costs can be justly attributed to production changes alone. In spite of this undeniable advantage, fixed-charge prices are not found very often in practice, probably because they may easily diverge too far from the actual prices.

The usual practice is to use the cost price which is almost identical with the "book value." There is no objection against this method as long as the cost prices and the market prices do not differ too greatly. When that is the case, however, it is good practice to take account of the difference—at least for the materials where they are of special importance, such as scrap, zinc, tin, copper, etc.—with the help of special accounts of value corrections, in which losses and profits produced by the fluctuations of the market can be booked against the quantity consumed and the balance will show the necessary correction of the result obtained by use of the cost prices.

For the rest it may be sufficient to say that the evaluation at cost price or book value will not cause any difficulties if the rules which have been laid down previously in regard to stock accounts and result accounts are observed.

It should not really be necessary to discuss separately the valuation of stocks, for stocks arise if deliveries have not been consumed completely, and it should be obvious that if deliveries to and issues from a stock account have always been made at cost price or book value, the balance, i.e. the stocks, will remain on the account at cost price or book value likewise. This simple relation is, however, sometimes upset by measures arising from the prudence of those responsible for the economic control and success of an industrial concern. Stocks which are in the works at the time of the yearly stocktaking should not be valued at a price higher than the cost price in the case of material bought from outside, or the production costs in the case of semi-finished or finished goods produced in the works itself. If there is a market price and this is lower at the time of the stocktaking than the cost price or the production price respectively, this lower price should be taken for valuing the stocks. This is the upper limit, but if it is considered suitable to choose an even lower price, it depends entirely on the opinion of the person responsible to do so, and use of this possibility is very often made in practice. Even in the course of the business year it may be desired to devalue the stocks in the same manner.

The best and least disturbing measure to adopt in such cases is to calculate the amount of devaluation necessary on a special account and debit it to the account as a whole, although the rule that a loss should not be shown on a stock account, but only on a result account, is violated by such a procedure. Of course, care must be taken that the price of the materials on the account is simultaneously changed and the new price used for issues from the account in future.

That may be sufficient to give an idea of the importance of the valuation problem, although many details have not been discussed rendering the carrying out of these measures in practice more difficult than may be apparent from the short description here.

Statements of Production and Sales Results

Accountancy through the Balance Sheet and the Profit and Loss Account provides the final results of the production and sales of any possible period, and if not otherwise stated it is usually taken for granted that the financial year of the concern in question is the basis of the figures. There can, however, be no doubt that accounts, built up according to the principles laid down in this book, will allow closing figures for shorter periods—a month or even a week—to be obtained. It rests completely with the responsible accountant how far he will go into detail in these short-term statements or what simplification he wants to use compared with the yearly Balance Sheet and Profit and Loss Account. The once much-discussed problem of these short-term statements can be considered solved in principle, although it is well understood that difficulties may arise to make the work much more complicated than it would appear from the above remarks.

However, this is not the object of the present considerations, which is to draw attention to the fact that the usual Balance Sheet and Profit and Loss Account give the final results of production and sale either only summarily or analysed from one point of view only, that of Accountancy. The management, however, is usually greatly interested also in other viewpoints, i.e. of departments and cost centres or costs as expressed by orders from customers or other sources, these orders being perhaps collected into groups according to their financial importance, their nationality or the districts of the various agents or representatives, etc. These analyses are shown by special statistics, which may be called Statements of Production and Sales Results—or more shortly Production and Sales Statements.

There is, of course, a close connexion between these statements and the Profit and Loss Account, and care must be taken that no discrepancies arise between them or if they do they should be cleared up or removed. Again under the term "discrepancies" only considerable differences are meant, since small differences can scarcely be avoided in comparing figures compiled by different methods, the double-entry method on the one hand and a statistical method on the other. The figures of Accountancy can usually be considered as correct as they, collected by book-keeping by double-entry, are already very strictly controlled arithmetically.

Further, it is obvious that there may be many ways of building up such Production and Sales Statements and that the management has to decide which way would best suit the concern in question.

The Production and Sales Statement is a comparison of the individual proceeds obtained for the goods dispatched in the month in question and of the production costs of these goods. The difference is termed the "dispatch result." The form in which this comparison is made is mostly that of an account with the proceeds on the one side, the production costs on the other, and with the dispatch result as balance. The arithmetical sum of the dispatch results of the individual items is the net result of the departments; it is, exactly as the dispatch results were, still divided into the individual items, but to this some items must generally be added which are kept on the books as one sum for the whole works, e.g. the selling costs and expenses and returns of a neutral character. Only then does the net result of the departments develop into the net result of the works which appears in the Profit and Loss Account given by Accountancy.

The amount of the invoice to the customer is the gross proceeds of the order in question. The sum of all such invoices against deliveries and services which make up the purpose proper of the concern is the gross turnover. The gross proceeds have to be diminished according to the booking customs of the firm. When these corrections are deducted from the gross proceeds the net proceeds result.

It is usual to divide the proceeds into groups within the individual products according to the various kinds of orders, and thus facilitate the analysis of the proceeds and results. How far such division should go can be decided in each case only according to the type and extent of the works.

As already mentioned, the costing side of the Production and Sales Statement consists of the costs of the products whose proceeds have been booked on the other side. These costs can be either the actual production costs as already explained or "standard costs," a term which will be defined later in detail. Here it may be sufficient to say that standard costs are those which would appear under normal conditions in the works, i.e. standard costs will generally be lower than those given above as actual production costs.

Furthermore a different procedure will be necessary according as the costs have been determined by order, class, or division costing. In the first case the costs of the individual products are directly given by the costing system; in the second and third cases only the costs per unit may be given by the costing system, and these have to be multiplied by the number of units of the individual products delivered during the month in question.

This short and superficial explanation of a Statement of Production and Sales Results may be considered as sufficient for the scope of this book. It is doubtful indeed whether the reader will be able to appreciate the difficulties with which the accountant is confronted when elaborating this statement, which as a rule has to be got out monthly, and the amount of clerical work connected with it. It must be added that the accuracy of the statement has always to be checked by comparison with the short-term balance struck for the same period as the Production and Sales statement; and again this comparison is not simple, as various corrections are necessary before it can be made. As an example of the difficulties encountered there is always the problem of correctly valuing the work in progress at the beginning and end of each month. Under these circumstances it is very doubtful whether the work put into these statements is really worth while and the accountant should welcome the modern development of costing to be described in the following chapter which renders these statements superfluous.

CHAPTER XXX

STANDARD COSTS

The general equations as developed above are very often reduced to the form

Total costs = costs of material + wages + overheads

where overheads are expressed as a percentage of wages. The terms "material" and "wages" are, of course, to be understood as abbreviations for the direct costs of these items.

The Influence of the Activity Factor on Costs

Now if the amount of work done—i.e. the degree of activity—falls off, the costs of wages and materials will decrease proportionally, but the overheads will remain nearly constant and fall off only slightly. From the above equation it is clear that this means that the percentage expressing the ratio $\frac{\text{overheads}}{\text{wages}}$ must increase and the total costs of production do not decrease in proportion to a decrease in activity. This explains why the costs of any product rise if the output diminishes. On the other hand, this decrease in activity very often indicates an economic depression, i.e. the demand on the market is less than the supply, and the result is a fall in the prices. If, however, at the same time the costs of a product increase and its market price based on costs drops, there is a danger that the margin between them—the profit—will diminish substantially or even become a loss.

These brief remarks have been made prior to the following more detailed discussion of the problem in question, in order to illustrate its importance. As a matter of fact the closer study of the subjects indicated in the heading of this chapter has completely changed the outlook of costing during the last twenty or twenty-five years, and has led to quite new developments and to a considerable simplification when applying these ideas in practice. It is true that these developments have not yet been everywhere appreciated in their entirety although authoritative institutions of accountants stand behind them, as the papers delivered to the International Congress of Management at Stockholm testify.

How Can Activity be Measured? In order to characterize the activity in a shop or in a works, either an actual output figure can be used, expressed in tons per hour or completed units per week, etc., or a relative figure, the degree of activity, may be more satisfactory. The degree of activity is measured by the ratio that the actual output of production bears to a given output of production, known as the "standard" which has to be defined in each individual case. This ratio can be expressed as a decimal fraction or, more usually, as a percentage. In either case, when using an actual figure or a ratio, the measure used must be accurately stated, and so must the moment or period, to which the figures refer; without that they are of no use for economic purposes. Although this is so obvious, these necessary conditions are frequently forgotten.

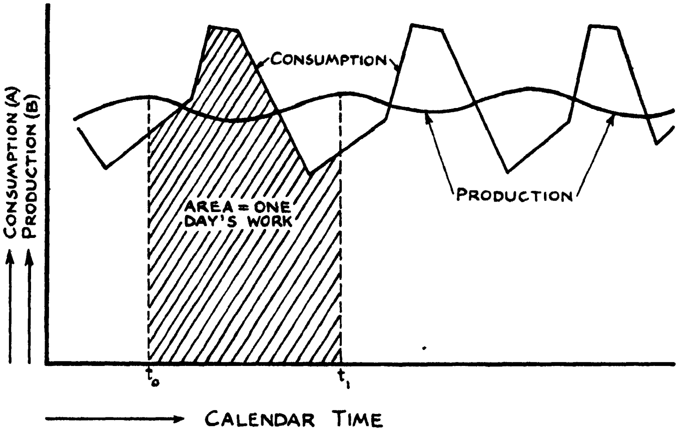

FIG. 27. PRODUCTION AND CONSUMPTION OF GAS

The Activity Factor in an Industrial Works. It can be considered exceptional when the activity factor can be given for a works as a whole; generally speaking, its shops or departments have different factors at the same time. For example, it has already been pointed out that production and sales and distribution are independent of each other to a large extent. It is therefore not surprising that the curves in Fig. 27 showing (*a*) the rate of utilization of the gas from a gas works, and (*b*) the rate of production of gas, differ considerably at the same moment. Only taken over a period of a day between t_0 and t_1 are they nearly equal, the fluctuations balanced by means of the gasometer. The curves in Fig. 27 show, therefore, only the "activities" of the production and utilization respectively. It will be the rule that they are equal only when the average is taken over a more or less extended period. Exceptions are the electric power stations, the maintenance and the traffic departments, etc. Sometimes even a single department cannot be considered sufficiently uniform to give one rate of activity, and it may be necessary to go into the working conditions of the individual cost centres. It must be left to the decision of the responsible man, how far to go in each case; it is quite impossible to give more than these general notes. There is also another point of view which should be kept in mind when determining the activity factor. This figure can be greatly influenced by "internal orders," for maintenance, for stock, and generally speaking by measures taken by the management for their own reasons, but which must be excluded, together with their consequences, if the activity resulting from the condition of the market is the vital factor in the decision.

Of the external orders only those which have already been taken into production are of influence when determining the degree of activity of production. Sometimes the orders on the books are considered as a correct expression of the monetary situation; it will understood that this is not quite correct. The difference may not be considerable in works where orders are usually executed a few days after receipt; but enough cases are known where this is impossible, especially in times of emergency. Neglect of this consideration may then lead to very unpleasant mistakes.

Finally, attention may be drawn to the fact that the activity of one and the same shop or department at different times, even when applying the same measure of activity, cannot always be compared; a further supposition is that no important change of the procedure of work, of the plant, or of the organization has taken place in the meantime. If, for instance, the measure is in both cases the number of "productive" working hours and the plant has been largely mechanized in the meantime, it may easily happen that the calculated activity factor has dropped to 60 per cent, while the activity measured by the output has even been increased or at least kept at the old level.

The Measures of Activity. There are innumerable measures which could be used for measuring the activity of a department or works, but in the long run they are nearly always based on, or connected in some way with, the quantity of work consumed or produced in a certain period. This quantity, however, is always the product of the intensity of utilization of the individual workplaces or machines or plants and of the time of this utilization, i.e. it is equal to the area in Fig. 27 bounded by one of the curves, the abscissa and the two ordinates indicating the period concerned.

The time of utilization may be the full calendar time, as, for instance, in the case of the engines at a public electricity works; it may be one, two or three shifts of eight hours, during twenty-five days per month, i.e. apart from the pauses for a rest, a shift time of 600, 400 or 200 hours per month, etc. In any case, it is easy in each individual case to determine the time of utilization accurately enough for practical purposes. That, however, is unfortunately not so with the intensity of utilization. It is very exceptional when the course of this intensity can be represented by a curve like those in Fig. 27, as, for instance, the load of an electricity works in kilowatts. Usually, measures must be used which show the intensity of utilization only approximately and under certain assumptions, which may be but are not always right: as, for example, if it is stated that 200 men were occupied in a department at the beginning of the month, but this number went down gradually during the course of the month to 150, and the number of men is then taken as the measure of the intensity of utilization of the department. Here, it is supposed that the quality of working of the men is and remains equal, but there is no production engineer who does not know that that is incorrect. Other approximate measures are quantities of production per unit of time, as cubic feet/minute for gas or tons/hour for rolled steel, etc., or the same items but expressed in money, either as expenses or as proceeds. The weak spots in these measures are obvious, and the change-over to the money measure makes the situation still more doubtful.

The measuring of the activity by the quantities produced can lead to wrong results if the semi-finished products within the department are not the same, either in quantity or with regard to the state of the production, at the beginning and at the end of the period taken into consideration; similar difficulties arise when using the output as a measure of the activity of the whole works.

Men-hours or machine-hours are often used as the measure of activity for production departments. They are simple and contain comparatively few sources of error. Besides, they are a product of both measures: time of work and intensity of work. For example, 5000 men-hours can mean that 25 men have worked 200 hours shift-time; but here also a tacit supposition has been made, i.e. that the load on the individual machines or the intensity of work of the individual men is the same, and that will always be the case only approximately.

Thus it must be stated generally that—apart from very simple cases of mass-production—all measures of activity should be considered with reserve and conclusions based on them should always be taken as only relatively correct. It may, therefore, be recommended to use two or three of these measures, one beside the other, in cases where it is of special importance to obtain a safe basis of judgment. Thus, one finds, for example, in general business reports or in prospectuses when applying for the admission of shares as marketable stocks, the production activity given simultaneously as an average of that of the individual departments *and* the total customers' orders received, these last two items expressed in quantities as well as in money, etc.

Rate of Load and Rate of Time Utilization. If a colliery produces 80,000 tons per month, it is possible that this result is obtained perhaps

in 25 days of 3200 tons per day,
in 22 days of 3635 tons per day, or
in 20 days of 4000 tons per day.

In such cases it is not sufficient to know the one figure of activity; there also should be stated the load and the time of the load, the activity being the product of both; in the example, for instance, 80,000 tons = 25 × 3200 tons. Just as a rate of activity has been developed from the figure of the activity, the terms "rate of load" and "rate of time-utilization" can be applied, the relations between these items being—

$$\text{activity factor} = \frac{\text{actual activity}}{\text{standard activity}} =$$

$$\text{rate of load} \times \text{rate of time-utilization} =$$

$$\frac{\text{actual load}}{\text{standard load}} \times \frac{\text{actual time}}{\text{standard time}}$$

The term "standard" is used in this connexion in order to indicate what may be considered as the basis of comparison.

How should these bases of comparison be selected? The upper limit of time-utilization is given by the calendar-time. As the length of years (leap year) and months is not constant, sometimes this upper limit is fixed uniformly at 365 × 24 = 8760 hours per year and 8760/12 = 730 hours per month, for example, in public electricity works, and this can be recommended also for industrial undertakings. This time may be termed the "maximum load time."

All other standard times depend on regulations made either by the works management or contained in agreements with the trade unions or ordered by the Government. Based on these regulations a "planned load time" can be calculated during which the works should work as a rule and according to their whole layout and plant. Usual planned load times are—

(1) The calendar time, if the works or departments in question are working continuously and a reserve plant in working order is at hand.

(2) The calendar time minus periods for overhaul, in special cases or continuous working of a single part of a plant which needs more or less regular stoppages for maintenance, etc., e.g. the day- and night-work of a low-temperature carbonization retort the lining of which must be replaced from time to time owing to the effect of heat.

(3) The calendar time minus legal holidays, all workdays being planned as three shifts of eight hours each. In this case an average calculation is often used of

300 days × 24 hours = 7200 hours per year, or
25 days × 24 hours = 600 hours per month.

(4) As under (3), but each day with one shift of eight hours, i.e. average calculation, 2400 hours per year or 200 hours per month.

When fixing the basis of comparison for the load the following circumstances should be taken into account—

(*a*) Each part of a plant and each working place has a nominal or continuous output or production; that is the load which can be put on the plant at least for the duration of the planned load time without interruption. (It should not be overlooked that the maximum load is different from this nominal load, not only in quantity but also in character, as the quantity of the maximum load depends largely on the duration of the overloading whilst the nominal or continuous load is a fixed item for each part of the plant.)

(*b*) It is possible in a department so to balance all parts of the plant and the working places that for a given quantity and type of product each piece of equipment and workplace is producing the maximum of which it is capable. If, however, the type and quantity of the products alter, it is probable that only some parts of the plant will be able to work to their maximum capacity. Other parts will work at less than full capacity; for the complete balancing of a plant for all possible kinds of production of which it is capable can for technical or economic reasons hardly ever be attained. This is, for example, nearly always the case in a rolling mill with a widely varying rolling programme, where the question of "bottle-necks" can be considered as the *bête noire* of the production man.

Thus one may distinguish—

(*a*) The balanced (or maximum) capacity: all parts of the plant are working simultaneously at full-load.

(*b*) The planned (not balanced) capacity: the capacity of a department for which its plant is built; but only some parts of the plant are working at full-load; they are the bottle-necks and they change this position with other parts when the kind of product is changed.

(*c*) The practical or normal capacity, kept generally somewhat lower than (*b*). Some capacity is kept in reserve and not utilized, to enable the department to adapt itself more easily to sudden fluctuations of load (changes of delivery dates; insertion of urgent orders, etc.).

In order to determine the basis of comparison for the activity the corresponding figures of load and time must be multiplied.

Standard activity = standard load × standard time.

While the standard time is clearly defined for use in industrial plants as the time available for the plant to work at full planned capacity defined at (*b*), the standard load can be either that load which will completely absorb the full planned capacity or that load which will completely absorb the normal capacity as defined at (*c*), above, depending on which basis the work is suitable for the case in question. There are, therefore, two different bases of comparison for the activity which follow from the two methods of calculating the standard load.

(1) The planned full activity is that activity which a works or a department attains when it operates at full planned capacity, without being overloaded, during the whole available time, taking into consideration limitations imposed by the layout, the plant, the means of transport, the working places, the organization and the programme of production.

(2) The "practical full activity" or "normal activity," which is generally lower than the planned full activity, say 85 per cent or 90 per cent of it, in order to give the works or the department some play to be able to follow sudden changes of the production programme.

The Costs Dependent on the Activity Factor. It is necessary when discussing the dependence of costs on the activity factor always to keep in mind the distinction between the costs of a works, a department or a cost centre, i.e. the total costs, and the costs of a special product, either semi-finished or finished, i.e. the costs per unit of production. The former are specially important for production control, the latter more for price fixing and price control, but the problem of the dependence of costs and the degree of activity seems to have quite a different aspect when considered from the point of view of the total costs or the costs per unit.

Not all types of costs—as already mentioned—change in proportion to the degree of activity. This, however, is mainly the case with the costs of direct material and direct wages; they decrease and increase in proportion to the output, thus they remain the same per unit, i.e. they are, so to speak, fixed from the point of view of the costs per unit. However, all these statements are not strictly correct in the mathematical sense of the word; they have to be understood with the reservation already familiar to the reader—that mathematical laws cannot be applied to economic problems with the same precision as to pure science. Thus direct wages per unit are generally lower the larger the number of units ordered in one batch; the price of material is lower, if more material can be bought all at once. But if these deviations from strict mathematical rules are ignored—and they are not large enough to change the whole character of the trend of costs—the statements already made and about to be made, are correct, and they certainly make it easier to understand how costs are dependent on the rate of activity.

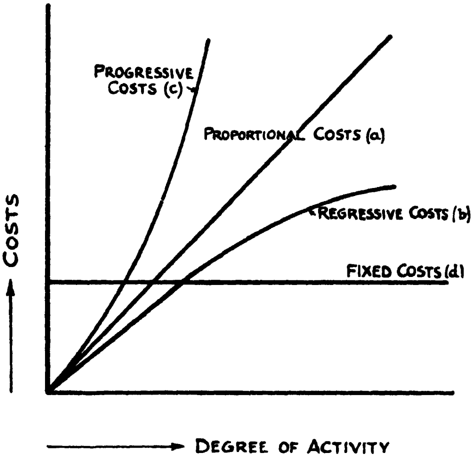

FIG. 28. TOTAL COSTS DEPENDENT ON THE DEGREE OF ACTIVITY

What has been said about direct material and direct wages is approximately correct also for some other types of costs: e.g. the use of tools, lubricating oil, wages for transport, maintenance, etc. These "proportional" costs are represented in Fig. 28 by the straight line *a*, through zero point ascending in the same proportion as the activity factor increases, and in Fig. 29 by the parallel to the abscissa.

Other types of costs increase more slowly than the activity factor, when compared with either the total costs or the costs per unit. They are termed "regressive costs." For example, the majority of salaries, costs of energy produced in the works, auxiliary wages (curves *b* of Figs. 28 and 29).

There are, however, also types of costs that increase faster than the activity factor, and increase both the total costs and the costs per unit. They are termed "progressive" costs and are of especial importance in the case of over-activity, i.e. if the works or the department have for some time more work to do than they are planned for.

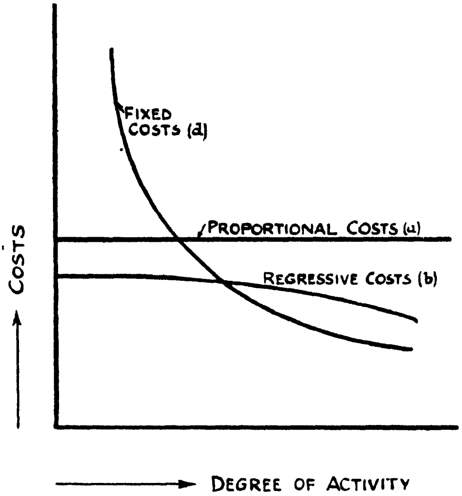

FIG. 29. COST PER UNIT DEPENDENT ON THE DEGREE OF ACTIVITY

In some circumstances any type of costs can become progressive costs, e.g. wages may increase quicker than the output in consequence of the payment of overtime and the diminished working capability of plant and operators. It may also be necessary to depreciate the plant and machines at a higher rate owing to overloading and changing personnel when working two or three shifts, and the resulting greater wear and tear (curve *c* of Fig. 28).

Finally, some types of costs are not dependent on the degree of activity, at least not if the change in activity is within certain wide limits, e.g. some taxes, some salaries, insurance costs, etc. They are termed "fixed costs" because they are constant considered from the point of view of total costs (line *d* of Fig. 28). But when costs per unit are taken into account, these fixed costs are the higher the smaller the output and they are represented therefore in Fig. 29 by a hyperbola.

It has already been mentioned—but is here repeated because it is considered important enough to be strongly emphasized—that this discussion of the different behaviour of types of costs with changing activity is only partly correct. Hence, it is justifiable for some purposes not to classify the costs into regressive and progressive, proportional and fixed, and to divide the total costs and the costs per unit into proportional and fixed costs only, particularly when the fluctuations of the activity factor are not too large. But this consideration should not lead—as it sometimes does in practice—to the suggestion that the actual behaviour of the different types of costs, when the degree of activity is changing, should not be watched closely. On the contrary very valuable information may be obtained, especially for production control, where it is sometimes one of the main objects of the production man to find out whether some costs, up till now considered as fixed, could be converted to some extent into proportional or at least regressive costs. It is also wrong to be too superficial in separating the proportional and fixed costs, perhaps putting the former on a par with the direct and the latter with the indirect costs. There are large parts of the indirect or general costs which must be considered as proportional costs.

Furthermore, it must be taken into account that such a distinction cannot be made once and for all; some costs may change their character in the course of time, and only continuous observation can find this out; what is correct in one works may be wrong in another. Finally, it is not a matter of indifference as regards costs whether a certain degree of activity is reached by a decrease from a higher or by an increase from a lower level. The costs are higher in the first case than in the second, because some types of costs, such as salaries, auxiliary wages, cost of transport, etc., cannot be easily accommodated to the change in activity. By analogy with mechanical and electro-magnetic phenomena this behaviour has been termed the "inertia of the costs" or the "remanence of the costs."

Change of Costs with the Activity Factor. After these theoretical discussions, some practical conclusions may be drawn from the knowledge obtained.

In the Table, page 334, the costs of a works are given for three degrees of activity, 100, 90 and 50 per cent., and in each case they are divided into proportional costs and fixed costs, as this seemed to be a fairly correct procedure in the case of these works. As for obvious reasons the absolute figures could not be given the total costs at 100 per cent rate of activity are put as 100, and the other figures are derived from this assumption, taking the fixed costs as completely fixed and the proportional costs as completely proportional. Although this may be correct enough for 90 per cent activity it is certainly wrong for 50 per cent, but the necessary corrections

	Activity factor per cent	100		90		50	
No.	Type of Costs	Fixed	Proportional	Fixed	Proportional	Fixed	Proportional
1	Raw material (direct) .		38·0		34·2		19·0
2	Wages (direct) . .		17·0		15·3		8·5
	General Costs						
3	Depreciation . .	3·0		3·0		3·0	
4	Interest on capital .	7·0		7·0		7·0	
5	Salaries . . .	14·0		14·0		14·0	
6	Auxiliary wages . .	0·7	5·2	0·7	4·7	0·7	2·6
7	Auxiliary material .	0·5	5·5	0·5	4·9	0·5	2·7
8	Maintenance . .		1·0		0·9		0·5
9	Rejects . . .		0·1		0·09		0·05
10	Insurances . . .	0·1		0·1		0·1	
11	Advertisements, price lists, etc. . .	2·0		2·0		2·0	
12	Commissions . .		2·0		1·8		1·0
13	Rates and taxes . .	1·8	1·2	1·8	1·08	1·8	0·6
14	Sundries . . .	0·8		0·8		0·8	
15	Total general costs .	30·0	15·0	30·0	13·5	30·0	7·5
16	Partial percentages of direct wages .	176	88	198	88	352	88
17	Total percentages of direct wages . .	264		286		440	
18	Addition at full activity, per cent . . .	264		264		264	
19	Covered general costs . ($\frac{264}{100}$ × direct wages) .	45 ($\frac{264}{100}$ × 170)		40·3 ($\frac{264}{100}$ × 15·3)		22·5 ($\frac{264}{100}$ × 8·5)	
20	General costs non-covered . . .	0 (30 + 15 − 45 = 0)		3·2 (30 + 13·5 − 40·3 = 3·2)		15·0 (30 + 7·5 − 22·5 = 15·0)	
21	Total costs . .	100		93		65	
22	Turnover = costs at 100 per cent, activity 10 per cent . .	110		0·9 × 110 = 99		0·5 × 110 = 55	
23	Profit (+) or loss (−) (turnover − costs) .	+ 10		+ 6		− 10	

TABLE OF THE CHANGE OF COSTS ACCORDING TO THE ACTIVITY FACTOR

will be discussed later on. When it is added that the turnover is calculated assuming that the selling prices are equal to the total costs plus 10 per cent and that it is further assumed that this selling price does not change when the activity decreases to 90 per cent or even to 50 per cent, the Table above will be self-explanatory.

What is shown in this Table in figures is now illustrated by the graph of Fig. 30A which will again be clear without detailed explanation. The vertically shaded space between the lines of the total costs and of the turnover characterizes the loss, and the horizontally shaded space the profit. It is obvious that the position of the point *C* where these two lines cut each other, is of the utmost importance; for the more this point *C*, known as the "critical point," moves to the left, i.e., towards the zero-point, the less sensitive are the works to a decrease of the degree of activity.

What are now the conditions on which the position of the critical point depends? They can be found by comparing the graphs 30A and 30B. The total costs and the turnover of the works represented by Fig. 30B is at 100 per cent activity, the same as those of the works represented by Fig. 30A, and in both works the costs of direct materials and wages are the same but the relation of proportional to fixed general costs is different. While in Fig. 30A it is 1 : 2, it is 3 : 1 in Fig. 30B. This has the effect of moving the critical point from 75 per cent activity down to 50 per cent, i.e. the higher the fixed costs the more sensitive is the works or the department to the fluctuations in activity.

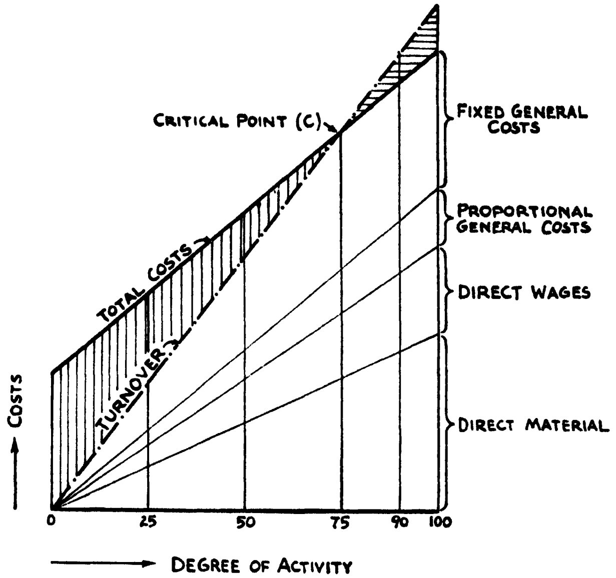

Fig. 30A. Connexion Between the Degree of Activity, Costs, and Profit or Loss

However Figs. 30A and 30B are analysed, the fact remains that it is the proportion which the fixed costs bear to the proportional costs which is the decisive factor in determining the position of the critical point.

This fact is of special importance for works where comparatively high fixed general costs cannot be avoided, as they result generally from large and extensive plants, the source of high depreciation; from large stocks of raw material, semi-finished and finished products which need the investment of considerable capital; from high salaries for specially trained experts; from the large and expensive organization and clerical apparatus invariably connected with large works and combines, etc.

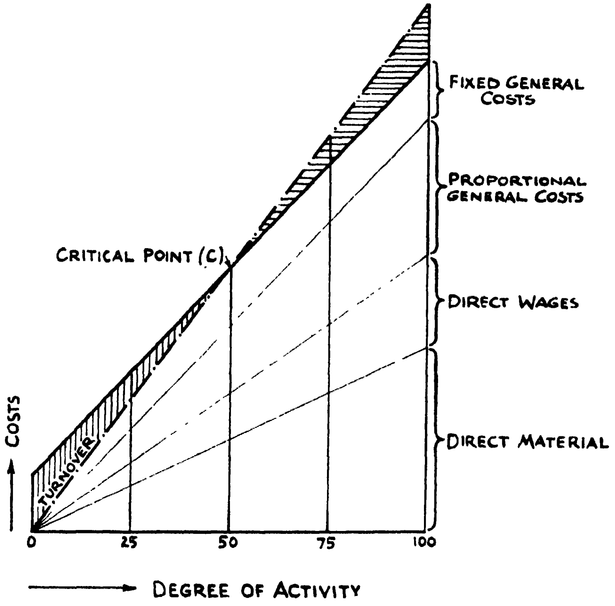

FIG. 30B: CONNEXION BETWEEN THE DEGREE OF ACTIVITY, COSTS, AND PROFIT OR LOSS

All this means that small works, in consequence of greater simplicity and clarity of the working conditions, are superior to the modern gigantic combines, because these latter are more endangered by the fluctuations of the market than the former. The combines have to counterbalance this inferiority by cheaper production methods based on their up-to-date plants and machinery and by using every possible effort to give the necessary flexibility to their organization in spite of its extent. What the best solution of this problem is, i.e. which is the most economic size of an industrial undertaking, is frequently discussed, but never completely answered;

and it is likely that no general reply can be given. Probably—as in most economic matters—each case is a separate problem and its solution is valid for this case only. There is no question that this problem arises in almost every industrial concern during the course of its development and the difficulties of its solution are shown very clearly by the history of industry in the near past, with its amalgamations and liquidations, centralization and then decentralization, organization, and reorganization, etc. This is not the place to go into the details of this problem which has been mentioned to show how important are the decisions which are based upon the figures collected and presented by costing.

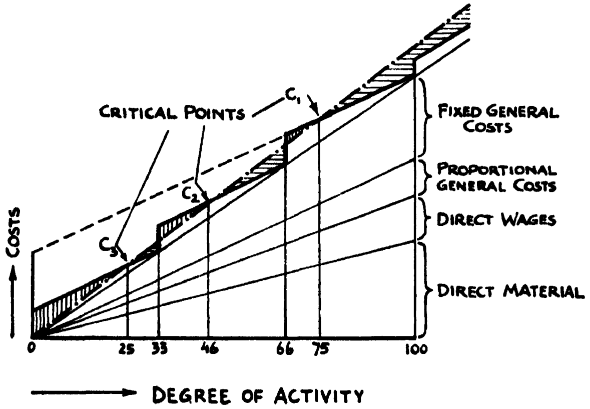

FIG. 30C. CONNEXION BETWEEN THE DEGREE OF ACTIVITY, COSTS, AND PROFIT AND LOSS

Finally, it should be noted that variations in the development of prices of items such as materials, wages and salaries that go to make up the costs will affect the critical point as well as the size of the turnover. If the selling prices of the finished goods decrease faster or more than the prices paid for materials, labour, etc. the critical point moves to a higher activity factor. In the reverse case, as, for example, at times of inflation, the critical point moves down the curve towards the zero point.

Now it must be repeated that Figs. 30A and 30B are only illustrations of a principle; attempts are always made in practice to avoid as far as possible the disadvantages which arise from incidence of the fixed costs, i.e., the management does what it can by arbitrary means to vary the "fixed" costs and so alter their characteristics that they increase and decrease like other costs, with the activity factor. Of course the change in the "fixed" costs can never be proportional to the activity factor, but it will nearly always be possible to decrease the fixed costs when the activity goes down for some not too short period. If this rate is, say, only two-thirds of the planned full activity, a set of engines in the power station can be stopped or some employees can be dismissed, etc. If the rate falls still further to only one-third of the planned full activity, other similar measures are used to lower the fixed costs still more: the line of the total costs represented in Figs. 30A and 30B by an inclined straight line is now converted into several such lines connected by vertical interruptions (see Fig. 30C) and there are several points at which these part lines are cut by the line of the turnover, C_1, C_2, C_3, i.e. the critical point *C* of Figs. 30A and 30B is replaced by a series of critical points. Perhaps there is now at a 50 per cent rate of activity no longer a loss of 10 per cent as shown in the Table on page 334, but a small profit instead; it is even possible that at an activity rate of 66 per cent a higher profit can be obtained than at 85 per cent, etc. Of course, Fig. 30C is only a made-up illustration of what may actually happen: the straight cost lines and turnover lines will actually be irregular curves, as the lowering of the costs may be possible only in small and gradual steps and the selling prices per unit fall when the market deteriorates, a fact which usually coincides with or is even the cause of, a falling activity. But the character of the whole development can well be recognized from Fig. 30C, which also shows that the utmost care must be used when endeavouring to forecast the effect of a change in the level of activity upon the trend of the costs.

All the calculations made so often in literature and used in practice as a basis for anticipating the trend of costs under changed conditions of activity must be considered, at least to a certain extent, as misleading. For example, the attempt has been made from a knowledge of the total costs and of their composition at 100 cent and of the costs at 0 per cent—which have been considered as the "fixed costs" in accordance with Figs. 30A and 30B—to build up the trend of costs for all intermediate degrees of activity. Even Fig. 30C, although itself still to a large extent a purely theoretical illustration, shows how incorrect, if not impossible, the results of this procedure may be. Figs. 30A, 30B, and 30C should be used to give clarity to the theoretical connexions and there they are very useful. If, however, actual figures are necessary, they can only be obtained by continuous observation of the movement of the costs in the works or departments and by drawing conclusions from this experience. In doing this it is again incorrect to take over from the past without any question the figures for a certain activity; it should rather, based on that experience, be considered and anticipated how, in the future, when the same activity factor occurs again, the working conditions and therefore the costs may differ from those in the past. This is not an easy task and it needs considerable time, and some may even think that the trouble to obtain reliable results is not worth while. It is easy to see that although Figs. 30A, 30B, and 30C are known to be inaccurate, they give at least an approximation to the true state of affairs and perhaps the best approximation possible. Why then use a more elaborate method which may not prove any more accurate? So far, so good; but in using the simple method too often without question, it is easy to forget the very wide assumptions and approximations on which it is based. From this it is an easy step to condemning all suggestions, merely because they do not fit neatly into the costing system and in extreme cases a "system of calculating costs at various degrees of activity" is launched upon the market as the latest cure for the difficulties of management. Experience has shown that it is better and safer to use the more difficult method, which, whilst it gives no results that can be picked out of a table, does procure as a by-product an intimate knowledge of the reaction of the works or the department in question to the measures taken by the management for keeping the costs within reasonable limits.

The Calculation of the Selling Price Based on Cost

What has been said above concerning the influence of the degree of activity on costs is certainly not new; it may indeed be said that ever since costing systems have been used in industrial undertakings it has been felt instinctively that that influence was very important. But the logical consequences of this knowledge have not been followed up. Costs have always been considered, at least to some extent, as something really fixed, as figures comparable to those based on the facts of physics, chemistry, and the like. Perhaps the expert, the accountant, did not make this mistake; he was well aware of "the relativity of the costing idea," but all the same he was afraid to stress this fact too much for fear of lowering the importance of his work in the eyes of the laymen, and especially his colleagues in the technical and commercial departments. This view should not be taken by anyone who wholeheartedly agrees that co-operation for the best interests of the undertaking should be incumbent on all concerned, for the benefit not only of works economics but of national prosperity.

There is nothing absolute about costs. They differ for one and the same object according to the purpose for which they are to be used, but this does not diminish the importance of the costing system itself nor of the services that the Costing Department could and should render to the undertaking as a whole. Admittedly this "relativity to purpose" connected with the costing idea seems at first glance to increase the difficulties of understanding the subject, but on the other hand it enhances the importance of the accountant's work, and if rightly comprehended and followed up to its final consequences, it results in the simplification and reduction of the clerical routine work to the benefit of all.

The upper and lower limits of the selling price of any goods are usually considered to be the obtainable and the acceptable prices respectively. Both are closely related to the degree of activity.

Every student of national economics learns—and daily life confirms the fact—that the price that can be obtained in the market does not depend only on the costs incurred in producing, selling, and distributing the goods in question. As is well known, the *laws of supply and demand* play an important role. In the long run, however, the *cost* will mainly determine the price or at least its lower limit, as no producer can sell his products for any length of time at a price lower than his costs without becoming a bankrupt. If free competition is possible, the price will depend on the price asked by those works which can produce at the lowest costs and can therefore offer the goods at the lowest price without making a loss. The others have to follow them at least for some time, if they do not want to lose the market; those which cannot lower their own costs sufficiently will be eliminated in due course. The result will be that on the whole "just enough goods" will be produced to meet the demand at a price which leaves a profit to the producer and supplier large enough to be an incentive to bear the risks always connected with industrial activity.

The reader will understand that these explanations are purely theoretical; in practice, many possible deviations from this development may occur; nevertheless the connexions explained are logical consequences and the course of events behind all deviations in practice must be as indicated. Thus, in the end, the costs really determine the price, not perhaps directly, as one is inclined to believe without taking into account the laws of supply and demand, but ultimately by indirectly influencing competition on the market.

(Incidentally, this also answers the often asked question whether it is of any interest to calculate the costs in the case of a "manipulated" market, i.e. if free competition is partially or completely eliminated by a ring or syndicate. Even in that case the prices must finally be based on costs, because experience has shown that no private syndicate is strong enough to neglect in the long run the laws which govern national or international economics. Whether it may be possible to evade these laws by governmental action is still undecided; we are in the midst of this struggle and it would be presumptuous to anticipate the result.)

The costs per unit of production differ, not only because the various competitors have to pay different prime costs of material and different wages and salaries or because they use more or less economical methods of production and have good or bad organizations, but primarly because they are mostly working at different degrees of activity. It has been explained that the higher the degree of activity in a works up to the limit of full capacity, the lower are the costs per unit of production, i.e. the lower the prices which can be offered to the customers. The obtainable price will therefore show the trend to be based on the costs in a concern working at full capacity. This state of affairs exists at a load which, according to the plan of the plant, the area of the works, the number and kind of the work-places, the means of transport, the production programme and the organization, can be borne continuously during a planned working time without over-exertion. It would be a contradiction of the principle of working economically, not to attempt to do this work with the least possible expense and therefore to plan it with that end in view. It may be that in practice this result cannot be obtained completely, because it is difficult to plan a plant and production without compromises due to practical difficulties; but the deviations from the original plan are not so large that they would endanger the final result to a decisive extent. Thus the conclusion can be drawn that the costs per unit of production are least when the plant is working at full capacity.

The consequence is that these costs form an important basis for calculating the obtainable price, so far as that price *can* be determined by calculation. The reasons why this calculation is possible only to a restricted extent have already been mentioned but are here repeated because of the importance of this consideration: apart from the law of supply and demand it must be kept in mind that continuous working at planned full capacity is not so favourable in practice as might at first be imagined. Where this state of affairs prevails the production lacks the necessary flexibility. Sudden changes in orders, in the disposition of labour, in dates of delivery, and stoppages due to breakdowns, etc., which are unavoidable in industrial works, cause more trouble in production departments working at full capacity than in those where the activity is somewhat reduced.

It is therefore common practice to plan the works for a somewhat larger capacity than it is intended to use continuously. Thus the planned full activity, which can certainly be maintained by the plant, but is not desirable for any length of time, must be distinguished from the practical full activity which can be considered as the "goal" of the works manager, and to which the term *standard activity* may be applied. As all works in the same branch of industry endeavour to attain this standard activity representing simultaneously the lowest costs per unit of production obtainable in the respective works, it can be understood that the obtainable price should be based on these costs which may best be termed *standard costs.*

Considering market fluctuations due to the march of events or seasonal influences, it is clear that in times of depression the activity in the works will be lower than the standard activity and the costs may be so much higher that no profit can be obtained or even a loss results. If the works is to be strong enough to overcome such difficulties it must build up a reserve in times of good business, i.e. to make the margin between standard costs and prices correspondingly high; on the one hand it would be unwise to put the price too high as this would certainly diminish the demand and bring on the danger of decreasing activity in the works. For generally the purchasing power of the customers allows only for a certain maximum price, and as soon as the price surpasses this limit decreased demand will be the inevitable consequence.

Time and again attempts have been made, by agreements between competitors, to adapt the price in times of depression to the actual increased costs, i.e. in comparison to the standard costs; but where success has been obtained, it has always been of short duration. High prices artificially maintained are an incentive to undercutting; and when the depression lasts some time there are always competitors who do not resist this temptation so as to attain higher activity in their works, and thus to lower their actual costs and bring them nearer to the standard costs. In other words, the result of this undercutting is that the price tends to be based on the standard costs. These costs are, so to speak, the "water gauge" of the obtainable price: times of high activity caused by seasons of favourable economic circumstances, and price agreements between competitors, allow the price to increase above the level indicated by this "gauge"; on the other hand, works with insufficient orders on their books lower it under the gauge level by undercutting.

In any case standard costs are the best basis for calculating the obtainable price, not only for the reasons already given, but also because each undertaking is able to work up its own standard costs either from the costs as determined during a period of operation at almost full capacity, or, if such a time has not yet occurred, by estimation based on the costs during the period of operation at the highest capacity already attained.

It need scarcely be mentioned, but may be added for completeness, that this discussion is of no importance in the case of a monopoly, i.e. products based on patents, scarcity of raw materials, etc. Then the price is almost independent of costs and would be estimated according to the utility of the goods and the capacity of the market.

In order to show the effect of these considerations on the obtainable price, an example may be useful. A colliery needs a hauling plant and asks various manufacturers for tenders. One of them is working only at 40 per cent of its standard capacity, while it is known that its competitors are in a somewhat better position. If the price is calculated according to present circumstances that factory would determine the total costs as follows—

	£
Raw material	1000
Wages	500
Overhead costs, 500 per cent of wages .	2500
Total costs	£4000

It is clear that it would be futile to ask a price based on this figure; but how can the obtainable price for such a plant be calculated even approximately? There is no market price for such a plant and the firm does not know the method of calculation of its competitors, particularly their percentage addition for covering the overheads. On some other occasion, however, a short time previously orders could be obtained at satisfactory prices when the factory was operating nearly at full capacity. At that time the percentage addition was about 300 per cent and the total costs of the plant would have been £1000 + 500 + 1500 = £3000. This figure has to be used as a basis for price calculation if the firm wants to compete successfully for the order.

Very often the question has to be answered in practice whether an order should be accepted at a low price if no higher one can be obtained. It has already been explained that costs are lowest if the works are operating at full capacity. As long as this degree of activity is not reached, the works should attempt to obtain it by accepting new orders. But if these can be obtained only by depressing prices, it must first be found out whether the higher activity will really increase the profit, or, if a loss has already occurred owing to the low degree of activity, whether this loss can at least be diminished by new orders.

The importance of these considerations may be emphasized by an example using actual figures. The costs of production in a concern at the present activity factor are: direct material £2000; direct wages £1000; general costs £2000, of which 50 per cent can be considered as proportional costs. There is a new order that can be obtained at the price of £210. The question is whether it should be accepted or left to the competitors. The estimated costs of direct material and direct wages for this order are £100 and £50 respectively; thus the output would be increased 5 per cent by this order. Based on these figures the calculation of the proportional general costs results in $0{\cdot}05 \times 0{\cdot}5 \times 2000 = £50$ and the total costs of the new order amount to $£100 + 50 + 50 = £200$, while to recover all general costs by treating both the fixed and proportional costs as proportional costs, they would amount to $£100 + 50 + 100 = £250$.

As the actual obtainable price, £210, is in between the costs calculated in the usual manner (i.e. with the proper percentage on direct wages to cover all general costs) and the calculation of the costs covering only the proportional part of the general costs, the order can be accepted as long as this kind of business is considered as an exception and does not degenerate into a habit.

The same or similar considerations apply if the question has to be answered, as is frequently the case—whether some object, a tool, a jig, a gauge, etc., should be manufactured in the workshop itself or bought from an outside supplier. First of all it is necessary to know the activity factor in the workshop. Very often the calculation is carried out without due regard to this factor and the result may be absolutely wrong. For example, suppose the workshop has a low activity; nevertheless the general costs are taken as 300 per cent of the direct wages and the costs of some tool are calculated as: material £3, direct wages £1 10s., general costs £4 10s., therefore total costs £9, while a supplier, known as a good manufacturer, submits a tender of £7 10s. for exactly the same object. It is obvious, however, that the manager of the shop concerned needs work to keep his trained and skilled men, who may be lost if working time has to be reduced too much owing to lack of work. Assuming that the proportional part of the general costs can be recovered by a 100 per cent on direct wages it is permissible in this case to use the following calculations: material £3; direct wages £1 10s.; proportional part of the general costs £1 10s.; making a total of £6, which is the additional cost which will arise if the work is done in the shop. As the additional costs are below the price quoted by an outside supplier the work may be done in the shop, but only if no other work is available at a price which will cover the fixed part of the general costs, in this case represented by 200 per cent on direct wages = £3. It should not be forgotten that the proper cost of the job is £9 and it should be placed with the outside supplier as soon as the rate of activity returns to a reasonable level.

The decision may, however, be very different when the shop is working at normal load, or even at full capacity, so that a new order would perhaps mean overtime or the engagement of new men, etc., and the costs would increase "progressively." Such a calculation in fact is valid only "under present working conditions" and has to be repeated as soon as they have changed considerably. The result should further be regarded only as one of the various factors which must be taken into account before making a decision. Other factors influencing the decision may be the special experience of the outside supplier, the necessary date of delivery, the secrecy of the drawings necessary for the production of the object in question, etc. i.e. mostly matters the value of which cannot be easily expressed in £ s. d.; but it is always useful to know from the calculation the financial effect of the decision as it will be contained in the final statement of profit or loss in the shop concerned.

Useful as it is to comprehend exactly what is meant by the term "acceptable price" and to apply this knowledge in suitable cases, the above discussion should have made clear how dangerous it is to exaggerate this application. Another point of view, which is often neglected but is nevertheless of great importance even for the individual works, is that of the industry as a whole, or at least of the branch of industry concerned; for everything detrimental to the whole will eventually develop into a disadvantage for each of the individual works. If there is one firm undercutting the prices, the other firms in the same branch of industry must follow in due course; if one competitor abuses the idea of the "acceptable price" by exaggeration, the others are soon forced to do the same. Thus the whole branch of industry may be brought down to the lower price limit or to even below this level. As a rule, in such cases the purposes of the undercutting, a higher activity factor, is not even attained, at least not in the long run and not generally. The individual concern which starts the undercutting can perhaps temporarily improve its degree of activity, but as the total turnover of a branch of industry is limited by the purchasing power of the population, and in times of depression this power cannot be increased above a certain level even by very low prices, the final result of undercutting is only that the obtainable business is done at a lower price level. This diminishes the general profit or even changes it into a general loss. Experience has shown only too often that these considerations are of eminently practical importance. It may therefore be repeated that the use of the lower price limit for the sales policy of an undertaking should be restricted to cases of real emergency, when the existence of the concern is at stake.

Determination of Standard Costs

How to determine standard costs needs explaining a little more than has been done.

The standard costs are known without further calculation when there has been a period during which the works have been operating at standard capacity, if all costs have been carefully recorded during this period. It must, of course, be assumed that this period has not been too short; for otherwise figures might be used which should be regarded as mere chance figures. The period must be long enough to be divided into two parts at least, the results of which could be checked against each other. Moreover, the figures from the various periods of full activity can be used as a basis only if the circumstances of production, e.g. production machines and methods or the composition of the product, have not been altered in the meantime. If this is the case, corresponding corrections are necessary, which must often be based on special investigations in the production departments such as method and time studies. These should be carried out by experts with sufficient technical knowledge and experience; for frequently such changes at one place in a department produce other changes at other places—and hence changes in costs—which less experienced and trained specialists could easily overlook.

If the highest degree of activity ever reached in the works falls far short of the standard activity, the standard costs must be calculated and estimated throughout. Everything that has been explained previously about the influence of the degree of activity on the development of costs must be kept in mind and carefully taken into consideration. Thus it may be necessary to convert even the proportional costs, as perhaps the raw material could be bought more cheaply in larger quantities when the works are operating at standard activity than when at only partial activity; piece-work prices for 5 to 10 pieces are perhaps 5 to 10 per cent lower than for one piece, and may be 25 per cent lower for larger batches.

It is obvious, however, that first of all it will be necessary to correct the fixed costs. One type of costs after the other must be investigated, to find out how they may be changed by the transition from the highest activity up to date to the standard activity., For example, the salary account should be considered person by person. It may be that the sum of the salaries of the draughtsmen should not be increased as new drawings are not necessary, the increase of activity being brought about merely by increasing the number of the individual batches, not by the introduction of new products. The sum of the salaries of the employees in the production departments, however, needs an increase, as more foremen and more clerks in the Wages Office or in the Planning Department are necessary, but this increase will probably be less than that of the degree of activity. On the other hand, the wages of toolmakers and transport workers may increase proportionally to the degree of activity, etc. These remarks may be sufficient to indicate how this conversion can be carried out, and simultaneously to show that this is not an easy job, but a very responsible one and one completely outside routine work. Intimate knowledge of the technical processes, of their connexion with each other, of the organization of the departments, of the conditions of labour and, of course, of the whole costing system, is absolutely necessary if this work is to be carried out in such a manner that the management can, without apprehension, make the important decisions which may be based on the knowledge of the standard costs. Moreover, the development of standard costs is no single event. When standard costs have been worked out and are in use in a works, continuous observation is necessary in case something may happen that might produce a change in the figures obtained. These changes must be found out quickly and brought to the knowledge of all concerned so that no wrong conclusions may be drawn from the old and now obsolete figures. Where necessary, objections must be cleared up by explaining how the new figures are arrived at; for these standard costs are a sign-post for everyone; it is not sufficient to show a man the figure; he must also be convinced that this figure has been obtained fairly and properly.

The average costs often used in practice as the basis of price calculation instead of standard costs must give wrong results if they are not obtained during a period of standard or at least nearly standard activity. These average costs are obtained as the average of some months, a quarter, a year or even some years, and it has been claimed that the use of the average method removes to a certain extent all fortuitous figures, so that the result is more accurate than that obtained by the calculation of standard costs. It is further said that if, for example, the average costs of the last two years are used, the fact that the works could exist for two years without becoming bankrupt would be sufficient proof that the selling prices did cover the costs sufficiently, because otherwise a loss would have been shown by the Balance Sheet. There is certainly some truth in the first of these statements, as any averaging method more or less eliminates the influence of contingencies, just because these contingencies are single happenings whose influence disappears in the mass of other figures used for building up the average. But this elimination of chance figures can be effected as well or even better by developing standard costs in the manner described above. When changed figures appear in the original cost data, the careful observer, watching the costs continuously, will soon find out which costs are the result of normal working and which must be attributed to contingencies and therefore eliminated when developing standard costs. It can even be expected that the result will be more exact than with the average method, where the influence of chance incidents is only decreased but not entirely eliminated.

The second reason, however, can be considered only as self-deception. Even supposing that in the last two years the costs have been sufficiently covered by the selling prices, that gives no surety that the same will happen in the future. Those who know what enormous changes occur in the course of two years even in works managed conservatively will agree that statistical figures, even if only partly based on such a long period of time can never have the value of those estimated by an intelligent observer of the development during the last few months. To use the average method over such a short period as a few months, deprives it of the only good quality it has, namely, that of being built up from a large number of figures, which give a certain guarantee of accuracy if they are consistent over a long period.

The graph Fig. 30C can be considered as an approach to a theoretical "standard cost diagram" if the line connecting the zero point with a point representing the total costs at a degree of activity of 100 per cent is taken as the representation of standard costs. This line shows for each degree of activity the total costs which would ensue if it were possible to adapt the costs completely to the changes of activity. It has been explained that this is not possible in practice and that the actual costs will not follow this line but are more likely to alter in a series of steps; the difference between the two lines shows how far the actual costs for each degree of activity deviate from the standard costs which can be considered as "ideal." Thus the management should always endeavour to reduce the differences between the actual and the standard costs as far as possible knowing that it will not succeed in completely eliminating them and therefore not blaming anyone as long as the differences do not exceed an amount that can be considered as permissible.

However, since the standard costs have been based not on the planned full capacity of the works, but on a smaller one—practical full capacity—in order to give flexibility in case of sudden changes of the production programme, it is quite possible that the actual costs may approximate very closely to the standard costs; cases have indeed been known where in practice standard costs have not only been attained but undercut. Therefore the denotation of standard costs as "ideal" should be somewhat modified; it may perhaps be correct to speak of them as a "practical ideal," an end that can be reached in practice in exceptionally favourable circumstances, but will remain unattainable in the majority of cases. These explanations may perhaps be considered as sophistry, as a mere "playing with words"; but anyone well acquainted with conditions in practice knows how important it is to define carefully new ideas when introducing them and to make clear to all concerned their meaning and application; otherwise they will only too often become the object of heated discussions and the cause of controversies which it was the purpose of their introduction to avoid.

It has been explained that the best basis for the calculation and fixing of selling prices are the standard costs; it is, however, very seldom that the actual costs, as they arise when an order is really carried out, are the same as the standard costs. They will be either higher—in the majority of cases—or lower, if the works have operated at the standard activity factor, which is a degree of activity only slightly less than the planned full capacity of the works would allow—even more economically than was expected.

This difference between the actual and the standard costs has to be dealt with in order to maintain the agreement between figures presented by the costing system and those of Accountancy, to ensure that the costing figures are correct as far as desirable in practice. The profit or loss for each product on each order can be shown separately by making a form of "post-calculation" of the actual costs using the returns from the shop which also form the basis of the accountancy figures. In doing this, the general costs are added, calculating the actual ratio which the general costs bear to direct wages, during the time the order in question is in production. Alternatively, it is, however, possible to credit the profits or to charge the losses as a whole during a certain period, say a week or a month, to the production departments where they have arisen. The first of these two methods was formerly the usual one and can still be found in many works, where this "complete calculation of the actual costs of all products of the works immediately after their production" is an object of pride on the part of the manager of the Costing Department. There is, however, the question whether the enormous amount of work connected with this "post-calculation" gives such valuable results that its continuance year in year out is justifiable. No one who has studied the use that has been made in most works of the figures finally compiled by this "post-calculation" can be quite positive in answering this question; this doubt must be considered increasingly justified the more the production in a works has developed from single to batch or even mass production. This means that "post-calculation" of this kind must disappear perhaps with the exception of rare cases, where a close investigation of actual costs for a limited time is required for a special purpose.

It is, however, not only the utility aspect that should be considered when it has to be decided whether "post-calculation" of actual costs should be continued or abandoned in favour of the second method of using standard costs. Are these actual costs really "actual" in the sense that they have arisen in the production of the goods concerned and in that production only? Apart from the repeatedly mentioned uncertainty always connected with cost figures, it is only necessary to investigate the differences in the actual costs of one and the same product produced at different times in the same works. These differences are perhaps caused by different factors in the shops concerned. Can the product in question be made responsible for this fact? Certainly not; the work to be done in producing the article was most probably the same, or nearly the same, at the time of the low activity factor as it was when the factor was high, and the difference in costs is only caused by the different activityfactors occurring each time the article is produced. This fact, however, has to do with the department concerned, not with the products manufactured in the department. It is therefore only logical to disregard the product completely when dealing with the difference between standard and actual costs and to charge the profit or loss to the department or shops.

This result could be expressed by stating that the costs really caused by the production of certain goods are the same at each activity factor, and that all other costs are "costs of readiness," of being prepared to do the actual work in the shops, costs arising from the fact that the whole production plant of the works, of a department, or a workshop must be available, even if all of it is not necessary under the temporary working conditions. It is therefore senseless, although one hears it again and again, to ask for the "correct costs"—an expression regarded as identical with the "actual costs" as they can be developed from the vouchers and books of accountancy. It can be stated of these actual costs only that they have been "correct" in one particular case in the past; it cannot be taken for granted that exactly the same costs will arise again in future even under the same working conditions. The false conclusion that is generally made with regard to the correctness of the actual costs, based on accountancy figures, is made especially clear in those branches of industry where the making of a product, e.g. a ship, a locomotive, a turbine, etc., takes a longer working time than is contained in a week or a month.

The result of these considerations, a result of the utmost importance for the whole development of cost accountancy, is that—

The *actual costs* based on the figures of accountancy should be determined periodically (weekly, monthly), but only for the works as a whole, or for a department or a workshop; the use of actual costs when calculating the costs of a works order or an individual product is misleading and should be omitted entirely.

Only *standard costs* should be used as the costs of an individual product for the calculation of the price of the product, whether the final fixing of the price is really based on these standard costs or cannot be so based because of market depression or other reasons.

There is no question that this result is at first surprising for people who have, perhaps for a long time, worked in the old way to base the costs of a works order or an individual product on so-called actual costs. They should try to refute the logic contained in the preceding considerations and they will find that it is a vain attempt. Besides they will become aware that by this transition from actual costs to standard costs the old contradiction between costing practice and the law of supply and demand has disappeared, which is conclusive evidence that the considerations are correct. (Sometimes it may be of interest to find out the difference between the actual costs and standard costs over a given period. Without dealing with this question in detail it may be mentioned that this can be done and has been done in a fairly simple way, while the same procedure applied to individual works orders or products is senseless and should therefore not be attempted.)

The Application of Standard Costs

Although it has already been explained in principle where to use standard costs instead of actual costs, it may be useful to dwell a little longer on the question of the application of standard costs.

It can be stated that the domain of standard costs is budgeting and estimating. Budgeting can refer to the undertaking as a whole and its various functions of investment, production, sale or finance, or to the various workshops and their working time, their output and their costs.

Budgeting an undertaking and its functions is naturally based on the budgeting of the various workshops and departments; as a matter of fact the same figures are used in both cases; they are only grouped in a different manner. As the workshops and departments are parts of the whole it is obvious that their figures can be obtained and then combined to give the figures for the whole more easily than vice versa. Now, budgeting is really nothing else but planning in terms of money; thus the whole work of budgeting rests ultimately on planning the workshops and departments, and as soon as it is clearly understood what planning means as a part of modern organization, the transition to budgeting is more or less a matter of common sense dependent in its details to such an extent on the peculiarities of the individual case that it is difficult—but also scarcely necessary—to develop general rules.

There is no doubt that great economic advantages can be obtained by introducing and applying this modern method in the right manner. Besides the advantages which can be expressed in money, the psychological effect on the responsible manager should not be forgotten; a man who has his works well in hand can feel well prepared against any future vicissitudes. He who has had this experience once will always tend to repeat it if he should obtain a new position in another works, and should certainly not be deterred by the objection that this method would not suit the new kind of production.

When looking back over what has been explained about planning as a whole and considering that the budgeting of a workshop or department is nothing else but expressing the probable consumption of material, working time and other expenditures of the department in money figures, it will be obvious that this budgeting is simple when based on the figures given by planning. From these the degree of activity can be calculated (provided, of course, that the capacity of the department and of its plant, machines, work-places, etc., is known), and it is then possible to stipulate beforehand the amount of expenditure allowed for the individual types of costs, taking the standard cost figures as basis and deriving the figures for the degree of activity in the manner described earlier in this book. Thus budgets for the various departments can be developed in all details, and works are known which issue such budgets weekly or monthly to each department and are in the habit of examining whether and where the actual figures of costs which occur during the periods covered by the budget differ from those budgets and why. There is no question that this is a very strong control of expenditure and that it tends towards economical working throughout the works. But the necessary supposition is that the budget figures are correct, i.e. adapted to the actual conditions of work, and that they are used in the right manner: they can never be considered as prescriptions or even commands; they can and should be only "signposts" showing an approximate amount. No blame attaches to anybody who exceeds or undercuts these figures unless mistakes or omissions are shown by special investigation.

In these circumstances the question arises whether the system of budgeting as characterized above and sometimes praised as the highest development of cost accountancy must not be considered as an exaggeration of an idea sound in itself. The author remembers various cases where the considerable clerical work connected with this arrangement was partly wasted by the fact that the comparison of the actual and the budgeted costs was carried out either not at all or too late, or that the correct conclusions have not been drawn from the differences discovered, or that the executives in the shops tried by all means, even at the cost of economy, to make the two sets of figures agree, etc. These words should not be taken as a warning against the idea of budgeting, but only against the wrong application of it; it would perhaps sometimes be better to keep back these figures from the shops and to use them only for office purposes, i.e. for developing the production-, sales-, or finance-budget instead of using them in the works' departments. But as already mentioned, the figures for each department are indispensable for building up the budget of the whole undertaking and of its functions with some surety that these budgets will correspond sufficiently close to reality. If the departmental budgets are at hand, it is only a matter of regrouping the figures to obtain the budgets for each function; and the sum of these functions leads to the budget of the whole works. This is done monthly or quarterly and the results are an important basis for the business policy of the management during the next month or quarter. Obviously correct figures are desirable but a warning must be given against trying to obtain too great an accuracy. Budgeting is a kind of prophecy, and as nobody can anticipate correctly what the future will bring it is bound to contain uncertainty and surprises. It is, therefore, often not worth while carrying out careful investigations to make sure that this or that figure is correct; it is in many cases much better to rely on the instinctive feeling which generally develops in a man who has to build up these budgets period after period. This again shows that this job is no routine, but needs a man of clear mind familiar with the whole undertaking and its working conditions and with full knowledge of the costing system and of the results of the work of the Costing Department.

It has already been mentioned that another branch of industrial accounts where the standard costs may be used advantageously is the estimating of costs which may arise in future. Estimating may deal either with the profitableness of a production method, or with the economic situation of a workshop or department, or with the business policy of a whole undertaking and may proceed in all cases to some form of cost comparison. It may also be carried out for *tender purposes.*

The much discussed topic of comparison of costs is treated here rather briefly, as otherwise much would be repeated of what has been mentioned elsewhere, but even so some repetition of general remarks is unavoidable if a clear explanation is to be given. Some examples are included to show the way in which this work should be done.

The object of cost comparison may be (1) a process, (2) a workshop or department of the works, and (3) a single undertaking or a combine composed of a number of different undertakings in each instance a financial whole. In all three cases comparison may be made either between the same objects at different times, when one may perhaps speak of "internal comparisons," as only figures of one and the same works are used, or of different, but to some extent similar and therefore comparable, objects in various works at the same time, when the term "external comparisons" could be applied. Thus six types of comparison would be possible in theory, but there are so many similar or equal features that it will not be necessary to consider closely each type separately.

The most important supposition for making possible a comparison is that the figures collected in the two cases to be compared are built up on the same basis. That means a *standardization* of ideas, which is comparatively easy for internal comparisons, but gives rise to many difficulties with external ones. Nevertheless, such standardization is absolutely necessary and should be carried out before the collection of figures is started. An attempt is sometimes made to compare the figures by remodelling them according to common definitions after they have been collected. This has nearly always given results which could not be trusted as the errors introduced by such transformations may be greater than the differences between the figures to be compared.

Furthermore, before a comparison is made, it has to be decided which part of the cost figure must be taken into account, as generally it is not necessary to regard a whole group of figures of which a considerable part may remain unchanged. How far to go in this direction depends entirely on the purpose of the comparison. It cannot be decided in general terms, but when thus separating the variable figures from the total in order to facilitate the work of comparison, the final result must be related again to the total, especially if, as in most instances, the difference should be expressed as a percentage of the total costs and not as a percentage of the variable costs alone.

On the other hand, the demand for standardization can be pressed too far, e.g. when it is intended to compare works of the same size or at the same degree of activity, or in the same state of mechanization, etc. Over-standardization may hide just those differences, the influence of which should be found out by the comparison.

These notes may seem perhaps so obvious as to be superfluous. Experience has shown that that is unfortunately not the case. They show, on the other hand, that the comparison of costs needs a careful and experienced hand and that anything like routine work is impossible.

When comparing processes, the term "process" should be understood in its widest sense. Process is usually understood to be a procedure used in the production shops, main or auxiliary, but it may also be a term applied to the supply of material, to the administration or to the sales and distribution. For example, it is a question whether some material should be supplied from a wholesaler or from a co-operative society. The prices per unit may be the same in the two cases, but the supply in the second case makes it possible to keep a smaller stock, therefore the interest on the invested capital is lower, and the dividend of the society can be considered as a further decrease in purchasing costs. In one instance, calculation proved that the profit made was 7 per cent if the overheads involved in making the purchase were ignored. This profit decreased to 6·2 if they were taken into account and increased to 10·1 if purchase was made from the society, thus confirming the old and often repeated but not always sufficiently considered principle, that "a penny saved in the buying is a penny earned."

This kind of comparison should be applied more than is usual in practice to the introduction of office machines. While production machines are always bought only after careful consideration of the profit that can be obtained from them, this is rarely the case with office appliances, which may often be found idle, because they are difficult to use or of no real advantage to the case in question.

The important problem—already touched on when planning was discussed generally—of whether the sale shall be from a stock of finished goods or directly from production or by mixing these two arrangements can be decided on a calculation of the costs of each alternative.

One of the most discussed questions in production is the size of the batches in which a given workpiece or a quantity of special material should be produced. A detailed and careful cost comparison showed *in a particular case* that the production costs went down as shown below, the first production of the workpiece in question being taken as 100.

Single new production		100·0
Repeated single production		50·0
Usual batch production	3 pieces	38·7
,, ,, ,,	10 ,,	29·8
,, ,, ,,	15 ,,	28·7
,, ,, ,,	30 ,,	27·7
,, ,, ,,	60 ,,	27·6
Varying production on continuous belt		23·2
Steady production on continuous belt		21·5

All these comparisons, of course, give only *one* indication as to the decision to be taken in a particular case. It may well be that the man finally responsible for the result of the business will disregard the resulting figures and decide contrary to them, owing to some consideration which cannot be expressed in money figures; but if he does, at least he knows what loss of money or what decrease in profit is involved in his decision.

When comparing the costs of several productions it is necessary to distinguish clearly which of the three points of view—accounts, cost centres or works orders—should be taken as basis, and the method of comparison will vary correspondingly. First of all, however, it is to be remembered that the costs for any production are not an absolute figure, fixed once and for all; they may change for many reasons, even when the place of manufacture, the product and the size of batch are the same. Reasons may be a change in the design of the product, even if it is not shown in the shape of the finished goods, a change in a process of production, the varying influence of other orders which have to be carried out at the same time, a change in organization, and especially a change in the degree of activity. These changes must be eliminated because a just comparison can take place only by "comparing equal with equal," but this elimination should stop short of obscuring differences which take place independently of the changing working conditions and the discovery of which is perhaps just the object of the comparison.

Thus it may be that the influence of the degree of activity on costs is to be eliminated. Then it is best to base the comparison on "standard costs." In another case it may be just the influence of the changing degree of activity which has to be investigated. This problem has been dealt with before but a further example is not out of place.

An electric power station driven by water turbines has a capacity of 10,000 kWh and the total cost of the plant was £250,000. With depreciation at £11,750 and salaries and wages at £1750 per annum, the fixed costs can be taken as £13,500, while the proportional costs at full activity amount to £2350, giving total costs at full activity of £15,850. As 365 × 24 × 10,000 kWh can be produced per year—

Proportional costs	per	unit	are	0·00644d/kWh
Fixed	,,	,,	,,	0·03700d/kWh
Total	,,	,,	,,	0·04344d/kWh

If the degree of activity is only 75 per cent the costs become £13,500 + (2350 × 0·75) = £15,262·5 and the production is reduced to 0·75 × 365 × 24 × 10,000 kWh.

Proportional costs	per	unit	are	0·00644d/kWh
Fixed	,,	,,	,,	0·04931d/kWh
Total	,,	,,	,,	0·05575d/kWh

i.e. 28·3 per cent higher than before.

Another very interesting investigation was carried out by the author some time ago. It was a case of a comparison of production costs, all external circumstances being as favourable as possible for such an investigation; the work, however, was difficult and the final result small, in spite of the efforts of all concerned to obtain a real success.

Three works, working independently, but financially united in a combine with pooled costs and profits, produced practically the same goods, the overwhelming majority of which were bought by only one customer, the railway company. The products were almost completely standardized by this customer. Detailed drawings with exact dimensions, tolerances, etc., and strict specifications of the quality of materials to be used, were at hand and yet the costs of the products originating from the three different works varied considerably and—what was more astonishing—irregularly with regard to their origin, sometimes one, sometimes another works having the highest costs.

A careful investigation brought to light some of the reasons for these differences, which were based on the different localities, equipment and manning of the three works. The first was highly mechanized, part of a combine where mass production was the objective of production; it was situated near the centre of a large industrial city, and had consequently a comparatively high turnover of labour, the workmen mostly being well trained in their jobs. The second works was near a town of middle size, also fairly mechanized but with a plant not completely up to date; the workmen, accustomed to their workplace and mostly well skilled and willing, did not like to change their situations, and could be considered steady and lasting collaborators, although other industrial works were not too far away. Finally, the third works was in more agricultural environment. The men, accustomed to farming and gardening, were not too eager to do their job. They sometimes even stayed at home when the work on the land or in the garden seemed to them more important, and the management, knowing it to be difficult to find substitutes quickly, were forced to overlook this irregularity.

When the investigation of the costs was started it was generally taken for granted that the lowest costs should be obtained in the first, and the highest in the third works, the second lying between both. For at that time it was believed that the fact expressed by the slogan: "Savings can be made only by increasing the overheads" had such an overwhelming importance that all other influences would disappear in comparison. This means, in effect, that the most mechanized must always be the most economical works. Without denying the truth contained in this sentence, it is well known to-day that this truth, like every other, can be converted into the contrary by exaggeration.

When it was clear that the anticipated result could not be obtained regularly, the reason was found first in some differences between the costing systems. Some wages were taken in one of the works as direct costs which could be distributed directly to the orders; in another works the same costs were considered as a part of the overheads, e.g. increased payment of overtime. In one of the works the analysis of the expenses was taken much farther than in another, etc.

It soon became clear that some standardization of the costing system was necessary to eliminate discrepancies between the calculations which originated from the different costing methods. But even when this work was carried through and the comparison of costs was started again, differences of absolutely irregular character remained and it was impossible to explain their reasons.

The author is inclined to-day to blame the existing piece-work prices for at least the greater part of the inexplicable irregularities. At that time the principles of fixing fair piece-work prices were not yet well understood. It was more or less a bargaining between foreman and workman, with all the well-known imperfections of this method of stipulating a piece-work price. This example illustrates how many and various are the considerations which should be taken into account when comparing production costs.

Similar considerations should apply nearly always, and almost every case has its particular features which can and must be taken into account. The difficulties are great but they are not insurmountable as long as "internal" comparisons are considered, i.e. those within the same works or at least within the same combine. Whether it is possible to make fair "external" comparisons of production, which are so often to be found in papers dealing with economics, is very doubtful so long as no extensive preparatory work has been done by some institution of scientific or economic character, such as the Institute of Cost and Works Accountants, the Institution of Production Engineers, employers' federations, etc. In any case, all results of such considerations should be used with the utmost caution as it is not possible to be sure that approximately the same bases of comparison have been used. In this connexion particular warning should be given about many of the comparisons between American and British production which appear in the press.

The object of comparing undertakings may be (1) their profitableness, (2) the realization of the invested value. At a first glance it seems to be obvious that the published Balance Sheets and Profit and Loss Accounts should be taken as bases of comparison, but anyone who knows how these statements are usually developed from the internal figures of Accountancy will agree that it is very doubtful whether a fair comparison is possible by this method. At least the "internal" Balance Sheets and Profit and Loss Accounts should be used, i.e. those which are not yet summarized for publication purposes, with concealed reserves, accounts put together, etc. And who, wanting to make external comparisons, is likely to have these internal figures? It is even difficult to collect them in a combine so that a faithful picture of the facts can be obtained because of what is only too well known in industry as "inter-departmental jealousy."

These considerations on comparisons of costs try to show the difficulties involved in the problem and the mistakes too often made, but the reader should not draw the conclusion that comparison of costs should be abandoned completely as the result will always be doubtful because of these difficulties and possible mistakes. It may be emphasized expressly that there is no question whatsoever about the usefulness of such comparisons, if carried out correctly; but the difficulties are mostly underestimated, many reasons for errors and mistakes are only too often overlooked, and figures which are obviously wrong are obtained and used to draw conclusions. The object of this discussion is to draw attention to this fact, but not to deter anyone from doing the work. Difficulties are there, it is well known, to be overcome, not to discourage.

Mention of estimating for tender purposes as one of the applications of standard costs can be brief, because the process of estimating for tenders has already been explained, although not expressly mentioned under this heading. Supposing an inquiry is received from a customer about goods the price of which is not fixed already by price lists, etc., one has only to use the general equations of cost calculation as developed previously and to apply standard costs to all figures of raw material, wages, and other expenditure necessary in the case in question. As far as the margin is concerned between the total costs and the selling price, the considerations with regard to the obtainable and the acceptable price must be used as a guide. That is about all that can be said generally, and it does not seem to be necessary to give any examples, as these can be taken from previous explanations. Moreover it would certainly mean going deeper into technical details than is compatible with the character of this publication.

CHAPTER XXXI

ORGANIZATION OF THE COSTING DEPARTMENT

The preceding description of Industrial Accounts as understood under the headings Accountancy, Works Accounts, Job Accounts, and Standard Costs, has shown their close connexions. This fact should be reflected in the organization so that a real co-operation is guaranteed as far as humanly possible.

While the Costing Department is mostly a supplier with regard to other offices, delivering useful services without which no proper economic control would be possible, there are also some departments on whose help the Costing Department relies and cannot work properly if this help is not given efficiently, accurately and at the right time. These are mainly the Stores, the Wages Office and the Invoice Department, the last denoting the two often separated offices for controlling suppliers' invoices and for making out customers' invoices. The vouchers coming from these departments such as material requisitions, wage tickets, copies of invoice, etc., are the basis on which the whole work of the Costing Department is built up, and it cannot be too often emphasized that these vouchers should not only be carefully developed as far as their printed forms and their course through the interested departments are concerned, but first of all correctly filled in and carefully checked. Only someone who has himself been responsible can perhaps imagine what a difficult and thankless job it often is, how again and again correction is needed of the same mistakes let slide by foremen and workers usually out of carelessness, but sometimes also to avoid too accurate a control, and by junior clerks and office girls through lack of understanding. The clearer and more concise the forms, the more easily will these mistakes be eliminated, and although a desire to limit the number of these printed forms is understandable, such limitation should not be carried to the point of endangering clarity in the instructions. The often proposed remedy to get rid of the help of foremen and workers completely by introducing special clerical staff for this job is certainly excellent, but costly, and is not always practicable. A method recommended in many cases is to distribute over the whole works persons or even small offices composed of clerical staff members (some of whom at least understand technical processes) to be responsible for this job: but care has to be exercised that by doing this and thus eliminating one difficulty (i.e. that arising from incorrect wages tickets or material requisitions) another difficulty does not arise from the somewhat doubtful position of these "works offices" in the chain of authority. This remark touches a very delicate spot in the organization of many works and in this problem also there is no universal remedy. The answer depends too much on the size, the layout, the tradition of the works, etc., and especially on the characters of the persons concerned.

If the author is to give a general advice from his own experience, he can only say: the larger the size and the area of the works, the more the individual production departments can work independently of each other, and the more the departmental managers approach the modern type, which declines to be a pure producer but is interested also in matters of organization and economic control, the more reason for subordinating these works offices to the departmental manager concerned. It should, however, not be forgotten that this measure may risk splitting the organization of the works into as many independent parts as there are departments and so losing the connexion between them. This must, of course, be prevented as experience shows that this state of affairs only too often leads to the departments working against each other.

The work in the Cost Department itself falls into two parts, of which unfortunately only one is usually considered when planning this work beforehand, i.e. the routine work, while the second part, the drawing of conclusions from the figures obtained by the routine work and special investigations in order to answer particular questions by the management, are usually considered as casual jobs which can easily be done as additional work by forces in reserve that may be made available by planning the routine work with the necessary care. Now it is obviously foolish to get in such a position; for the results alone of the routine work usually say very little, if anything; it is the conclusions that can be drawn from or built up on them that matter; and it is therefore probable that the above standpoint has not been chosen intentionally or, if it has, then its consequences have not been properly appreciated. The manager of the Costing Department is then in the difficult position of being unable to satisfy the demands his "customers" are entitled to make, i.e. to render to the other departments the services they rightly expect, because his staff is too small or at the best lacks the trained people necessary to obtain the results and answer the questions specially asked by the management of the works.

It is only too easily forgotten that the Costing Department is first of all a service to the other departments and the management; that each result it gives out may create a further inquiry which again requires special work additional to normal routine jobs, and so on, and that a certain part of the departmental staff must be reserved for the quick delivery of these answers.

The development of the list of accounts or types of costs and of cost centres is an important part of the preparation of the Cost Department *routine work.* As previously mentioned, both lists should be discussed in detail with the works and commercial managers concerned before they are finally fixed. Care should be taken that organic changes in the structure of the works inevitable in the course of time are quickly reflected by alterations of these lists.

In Accountancy the actual book-keeping by double-entry forms the most important part of the routine work resulting in the Annual Balance Sheet and Profit and Loss Account. It may be called to mind that if Accountancy is carried out in the manner recommended, the short-term (monthly) closing of books and balancing can be done with sufficient correctness and not much additional clerical work, thus showing the result of the past month perhaps on the 10th or 12th of the following month. The work can even be arranged so that the Annual Balance Sheet and Profit and Loss Account can be finished with little more work than the monthly ones.

The routine work of the section "Works Accounts" consists mainly in the distribution of the costs to the cost centres, the determination of the percentage additions representing the actual overheads and the development of the corresponding additions representing the standard overheads. Of course, the latter will not change from month to month, but should be kept constant as long as possible; it is as well, however, to confirm them once a month, as experience has shown that such figures are easily kept too long unchanged and then they no longer reflect the actual development of the working conditions in the works.

As for job accounts, only standard costs should be used, the "post-calculation," i.e. the determination of the costs of orders, after completion, should be limited to one sample only of each type of production as long as the section "Works Accounts" reports that the standard costs have remained unchanged. The same applies, of course, to the "pre-calculation" or estimation of costs for tender purposes, where the routine work, if one can call it that, is certainly also made easier by the use of standard costs, but the reduction of the real work to be done is not so large as with the determination of the costs of orders already completed.

Finally, a few remarks may be added about the necessary statistics which are often considered as part of the routine work of the Costing Department.

Before starting any statistics it should be carefully investigated whether the figures that may result from this work are really needed by the management for decisions that may come round in the usual course of business. The manager of the Costing Department will seldom have the scope to settle this matter alone. A discussion in detail with the general, works and commercial managers and the departmental managers will be necessary, and in these discussions reference should be made to the essential statistics only. For there can be observed in practice an inclination to ask for all kinds of figures which are then provided week after week and month after month without being used or even looked at. Similarly the distribution of statistics should be limited to those who by their work are actually interested in the figures contained in them. The reason for this demand is not any kind of secretiveness, but the wish to give to everybody responsible for a certain part of the work as easy a survey as possible of his domain without disturbing him by an enormous quantity of figures, which have no connexion with his own job.

And again, nearly all these figures are meaningless when considered as absolute for an isolated week or month. They gain importance only by comparison with the figures of earlier periods, and it is therefore usual to find in these reports not only the figures of the last week or month, but also the figures of the last but one and the average of the figures during the year in progress as well as during the last finished year. This, however, renders the reports still more bulky and difficult to survey. In order to avoid all these disadvantages it seems to be correct to develop for each leading person entitled to the receipt of statistical figures special forms, large enough for a year, or at least a quarter of a year, into which the new figures can be entered week by week or month by month. Of course, this means that the use of nearly all modern means of reproduction has to be renounced and to that extent clerical work will increase. In return one has the satisfaction that what is given to the leading persons is of direct use to them and will therefore be much more appreciated than reports which need summarizing and rearranging before being of real use to the receiver.

Whether these figures should be shown in the form of tables or graphs is usually a matter of taste, but sometimes one or other kind of representation is preferable and depends not only on the object of the figures but also on the personality of the manager for whose use the statistics are prepared. Human beings are, fortunately, not yet "standardized" and while one will understand graphs easily, another will prefer tables. It will depend on the skill of the Cost Department's manager to satisfy as far as possible all personal wishes, whilst remembering that some uniformity is in the interest of economy. Thus it has been found useful, for example, to collect the statistical figures into three groups, which can be the same in nearly all production departments. The groups are (1) working time expressed in hours or minutes, (2) output in quantities, weight or number of pieces and (3) costs in money. The opportunity may again be taken to point out how important it is to have figures of time and quantity for comparison purposes. Money figures often vary, due to fluctuations in rates of labour and prices of materials, which makes a comparison of figures obtained at different times and places difficult and uncertain. Of course, finally, when the economic result of the works has to be determined and analysed, money values cannot be avoided, as they serve as the common denominator for all types of goods and services which can be compared only on the basis of their cost in money.

The exclusive use of standard costs in job accounts renders unnecessary the production and sales statement in the form explained before; for the percentage of profit on a certain product is known by comparing its standard costs with its selling price, and, by summarizing the invoices of a period according to the various goods sold, it is easy to determine the share which each of these goods has on the total profit. A large and difficult job is changed into a simple summary.

CHAPTER XXXII

CONCLUSION: THE TASK AND THE RESPONSIBILITIES OF MANAGEMENT

RECALLING to mind what was said in the introduction about the meaning of the word "management," it could perhaps be said that the whole contents of this book deal with the tasks and the responsibilities of management. It will, however, have been written in vain if it is not now obvious that *no one book*, like the present, can possibly be more than an introduction to a subject which nowadays touches every activity in which men engage. If it is not possible to give a precise outline of the duties of management, it is quite as impossible to define, except in the widest terms, the qualities needed to make a good manager. Fortunately, in practice these qualities are more easily recognized than described and classified. Whilst all the aids of modern psychology and training should be used in selecting managers, there is no real substitute for the personal interview and impressions, a fact widely recognized by the various methods of selecting officers for the Army during the war, which were largely extensions, if somewhat elaborate and strenuous, of the personal interview. What is perhaps not so widely recognized is that the best training for management is to manage, to have responsibility for others' work and behaviour and to have it at the earliest possible age. To do this means a very great delegation of responsibility, the very antithesis of that centralization which seeks to control every action of every person within its reach. Central direction is, of course, necessary, but it should operate as a policy-making centre, and as a general lubricant, smoothing out difficulties and disputes before they arise if possible; if not, then acting as an impartial court of appeal.

Put briefly, all this means is that the right way of dealing with the human factor must be found if industry is to progress or even perhaps continue. Thinkers and men of action from all walks of life agree on this one point, however much they may disagree in the treatment of the human factor or even in defining it, and it is not intended to write another article which could hardly add any new idea to what has been said, written and printed elsewhere. Instead it is preferred to direct attention to several of these articles to which the reader may turn if he so wishes. The selection (see Appendix IV) may be considered rather haphazard; but it is made with the intention of giving quite modern or less known sources, partly from this country, partly from U.S.A., which are representative of present opinion in both parts of the English-speaking world. The reader interested in this subject will not regret having studied these publications for they will certainly make him think, even if it is only to find reasons for refuting and disagreeing with them.

One short book, however, should be singled out of these publications not only because it is partly connected with the problem discussed, but mainly because it tries to answer a question that has come very much to the fore when discussing the troubled world that the last war has left to us: is science and industry, as we know it to-day, bad in itself or is it only badly handled and applied? The author does not need any introduction, and we may wholeheartedly agree with the words of his publisher on the cover of Charles A. Lindbergh's book, *Of Flight and Life.*[1]—

> The personality and insight of a unique individual—one whose experience of flight and life is unique—give a strange force and significance to this little book, in which an airman, who is also a student of science, attempts to clarify the crisis the world faces, to communicate with men and women of similar concern, to search for a solution. The flight of his thought in these pages is like the flight of his, so many years ago, across the lonely wastes of the Atlantic. It is as solitary and as daring.

After a lively and breath-taking description of some significant events in the war, 1939–1945, Lindbergh discusses the conclusions he felt himself forced to draw from them and comes to the following confession—

> It took many years for me to discover that science, with all its brilliance, lights only a middle chapter of creation, a chapter with both ends bordering on the infinite, one which can be forever expanded, but never completed. When man devotes too much time to this chapter, he loses the greater value of the book.
>
> Now I have lived to experience the early results of scientific materialism. I have watched men turn into human cogs in the factories they believed would enrich their lives. I have watched pride of workmanship leave and human character decline as efficiency of production lines increased. . . . Man sets up a system around his theories and inventions to compete with a divine plan unfolded through the ages. He forgets that his science is of value only so long as it improves his life as it was meant to, and that unguided knowledge is as limitless and meaningless as space. . . . Man has never been able to find salvation in the exact terms of politics, economics, and logic. From Plato's Republic to Roosevelt's United Nations, his planned Utopias have not proved the answer, for the answer is at a deeper level. Our salvation and our only salvation lies in controlling the

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[1] Charles Scribner & Sons, New York, 1948.

arm of Western science by the mind of a Western philosophy guided by the eternal truths of God. It lies in the balanced qualities of spirit, mind and body of our people. Without this control, without this balance, our military victories can bring no lasting peace, our laws no lasting justice, our science no lasting progress.

APPENDIX I

CONDITIONS OF SALE

(Reproduced by courtesy of K. & L. Steelfounders & Engineers, Ltd., and Browett Lindley, Ltd., Letchworth, Herts.)

1.—General. This Tender is submitted on the distinct understanding that notwithstanding anything in your inquiry or specification or acceptance or order to the contrary, the following terms and conditions are to apply.

2.—Acceptance. The acceptance of this Tender is subject to our confirmation and must be accompanied by sufficient information to enable us to proceed with the order forthwith. We are to be at liberty to amend the Tender prices to cover any variation in cost that has taken place after tendering. Any samples submitted must be returned to our Works, Carriage Paid, within one month from dispatch, or paid for.

3.—Packing. Packing cases will be charged separately and will be credited when returned Carriage Paid in good condition within one month of date of dispatch. Packing cases for shipment abroad are non-returnable and must be paid for unless allowed for in Tender.

4.—Limits of Contract. This Tender includes only such goods, accessories and work as specified herein.

5.—Drawings. All drawings, descriptive matter, weights, dimensions and shipping specifications submitted and the descriptions and the illustrations contained in our catalogues, pamphlets, price lists and other advertising matter are approximate and by way of identification only and are intended merely to present a general idea of the goods described therein and their use shall not in any circumstances constitute a sale by description. Notwithstanding that a sample has been exhibited, such sample was so exhibited and inspected solely to enable you to judge the quality of the bulk and not so as to, and shall not, constitute a sale by sample under the Contract. Certified outline drawings will be supplied if necessary after acceptance of this Tender, but we do not undertake to supply copies of detailed drawings. When drawings are submitted for approval, they shall remain our property and shall be treated as strictly confidential and shall not be divulged to third parties without our written consent and shall be returned immediately upon our request.

6.—Tests, Inspection, and Performance. Our manufactures are carefully inspected and, where practicable, submitted to our standard tests at our Works before dispatch. If physical tests on materials, or running tests, in the presence of you or your representative, are required, unless otherwise agreed, these will be charged extra, and in the event of any delay on your part in attending such tests after seven days' notice that we are ready, the tests will proceed in your absence and shall be deemed to have been made in your presence and shall be recognized by you. Any performance figures given by us are based upon our experience and are such as we expect to obtain on test but we can only accept liability to obtain the figures given when we guarantee such figures within specified tolerances under an agreed penalty (as liquidated damages) and bonus if the figures obtained exceed the tolerances. You assume responsibility for the capacity and performance of the goods being sufficient and suitable for your purpose.

7.—DISPATCH. The time given is for dispatch from our Works and is to date from receipt by us of a written or telegraphic order to proceed together with all necessary information to enable us to put the work in hand. We will not accept cancellation or partial cancellation except with our consent and on terms which will indemnify us against all loss. We will use every endeavour to dispatch on the date given but will accept no liability for failure to do so, whether on account of direct or consequential damages, unless a written guarantee specifying the liquidated damages shall have been given by us and you have suffered loss by our delay. In the event of the suspension of the work by your instructions or lack of instructions the contract price shall be increased to cover any extra expense thereby incurred by us. Should dispatch be delayed by your instructions or lack of instructions, or by any cause whatsoever beyond our reasonable control, including strikes, lockouts, war, fire, flood, accident, defective materials or delay in obtaining materials not manufactured by us for this contract or any other cause of similar character, a reasonable extension of time shall be granted.

8.—STORAGE. If we do not receive forwarding instructions sufficient to enable us to dispatch within fourteen days after notification that the goods have been inspected or tested under Clause 6 or are ready for dispatch you will take delivery or arrange for storage. We are prepared, however, if our storage facilities permit, to store the goods, making a charge of 5s. per ton or 40 cubic feet per week (with a minimum of 5s. per week) for storage and fire insurance, plus an additional charge for any double handling, cleaning, repairing, etc., which might be involved, until the goods are dispatched. Any charges for storage or demurrage after dispatch must be paid for by you.

9.—DELIVERY. Where the price quoted specifically includes delivery, then for delivery to the United Kingdom the price quoted includes delivery only by any method of transport at our option within the usual free delivery area as if delivered by rail, subject to the Standard Terms and Conditions of Carriage of Merchandise as settled from time to time by the Railway Rates Tribunal.

When goods are consigned on your instructions by Passenger Train or other means involving extra cost, the excess will be charged unless included in our estimate. When delivery to the site is included in the contract, you will provide a suitable and safe roadway to the site, otherwise the contract will be considered fulfilled by delivery being made to the most suitable depot of the carriers.

For Export, delivery f.o.b. or c.i.f. ship slings, port stated in this Tender is included. Unless otherwise specified no lighterage, landing charges, dock, wharf or customs dues are included. Freight and insurance charges are based on the rates obtainable at the date this Tender is made. If these rates are increased or decreased from any cause between the time the Tender is submitted and the date on which the goods are dispatched, our price will be increased or decreased by the net amount of the increase or decrease in such charges. A document in any form certifying that insurance has been effected (and whether or not other goods are included in or covered by such insurance) and endorsed by us may, at our option, be tendered instead of a policy of insurance in respect of any goods sold c.i.f. and you shall accept such document in lieu of a policy, together with invoice or invoices and bill or bills of lading as complete legal tender and/or delivery of shipping documents by us under any such contract or sale.

10.—TERMS OF PAYMENT. Unless otherwise agreed the prices quoted are strictly net monthly ex Works and due upon notification by us that the goods have been inspected or tested under Clause 6, and that they are ready for dispatch. Goods for shipment abroad are net cash unless otherwise agreed on presentation in the United Kingdom of invoices, and any shipping documents taken out or notification that the goods are ready. If from any cause beyond our control we are not able to dispatch the goods, payment of the contract value of the goods shall be due upon presentation of invoices and notification from us that the goods are ready for dispatch, and payment shall be made in full as though the goods had been dispatched. Any liability on our part is subject to these terms of payment and all other of your obligations to us under the contract being strictly observed. No delay in starting up or using machines or other goods supplied from whatever cause and no defect discovered after use shall interfere with payment by you in accordance with the terms laid down in the Tender. We reserve the right to deliver any one or more consignments, each consignment to be paid for in accordance with the foregoing terms and in the event of payment not being made for any one consignment, we are at liberty to suspend all operations in connexion with the contract pending satisfactory settlement being arrived at. In addition to any lien to which we may by statute or otherwise be entitled, we shall (in the event of your insolvency) be entitled to a general lien on all goods in our possession (although such goods or some of them may have been paid for) for the unpaid price of any other goods sold and delivered to you by us under this or any other contract.

11.—LOSS OR DAMAGE. When the price quoted includes delivery in the United Kingdom we will repair or replace free of charge goods damaged in transit provided the carriers and ourselves receive written notification of such damage within three days of delivery but not otherwise.

In the case of goods for shipment abroad, we will not be responsible for loss or damage or deterioration from whatsoever cause arising to goods beyond the point of shipment. We shall not be liable to give notice under Section 32 (3) of the Sale of Goods Act 1893 or otherwise that we do not accept any responsibility. When bills of lading are taken out by us on your behalf we will on your instructions and at your expense insure against loss or other risk, and will on receipt of your indemnity take all reasonable steps to recover from the underwriters any loss or damage for which they may be liable.

12.—GUARANTEE. Save as provided in Clause 6, in lieu of any warranty, condition or liability by Law, our Liability in respect of any defect in or failure of the goods supplied, or for any loss or damage attributable thereto, is limited to making good by replacement or repair defects which, under proper use, appear therein and arise solely from faulty design, materials or workmanship within a period of twelve calendar months after the original goods shall have been first dispatched, at the termination of which period all liability on our part ceases. Provided always that such defective parts are promptly returned free to our Works, unless otherwise arranged.

The repaired or new parts will be delivered free at the place specified in the original contract.

We accept no responsibility for rectification carried out without our consent.

In the case of ball and roller bearings, accessories, materials and other goods not of our make, you are entitled only to the benefit of any guarantee given to us in respect thereof.

13.—MACHINING CUSTOMERS' MATERIAL. Customers' material shall be delivered to and collected from our Works free of all expenses to us as our price for machining only does not include either handling charges or the cost of freight in either direction. If we are required to meet any such expenses, they will be charged to you at their full cost, as also will the cost of packing cases. All metal removed becomes our property and is allowed for in our estimate.

Should any material sent for machining, grinding, heat treatment or hardening, etc., be spoiled, we do not accept responsibility for the value of such material or the cost of any prior operations performed thereon (same conditions also apply to finished parts sent for fitting or other purposes). We further disclaim any responsibility for the failure of all such parts due to any defects whatsoever. Every precaution is taken to avoid waste and extra material is only called for if absolutely necessary.

Customers' material shall be reasonably soft, homogeneous and suitable for rapid machining, and should any material be spoiled owing to hard places or defective material, it is understood that we are to be paid for the work done and any consequential damage to cutters or other tools, in addition to our not being responsible for replacements. We do not undertake to check or to rectify customers' material, neither do we accept responsibility for loss or damage after dispatch.

14.—PATENTS. When machines or parts of machines are supplied to customers' designs, we do not hold ourselves liable for infringement of any patents or other rights, and the customer shall keep us fully indemnified for damages or costs incurred by us in regard to any proceedings brought against us by any party claiming patent rights in respect of goods manufactured by us to your order.

15.—ARBITRATION. If at any time any question, dispute, or difference whatsoever shall arise between you and ourselves upon, in relation to, or in connexion with the contract, either of us may give to the other notice in writing of the existence of such question, dispute or difference, and the same shall be referred to arbitration in England of a person to be mutually agreed upon, or failing agreement, of some person appointed by the President for the time being of the Institution of Mechanical Engineers. The submission shall be deemed to be a submission to arbitration within the meaning of the Arbitration Acts 1889 to 1934, or any statutory modification or re-enactment thereof.

16.—LEGAL CONSTRUCTION. The contract shall in all respects be construed and operate as a Contract governed by English law and unless otherwise arranged is subject to the jurisdiction of the English Courts. The legal construction of the clauses shall not be affected by their titles.

17.—SUPPLEMENTARY CLAUSES.

(*a*) The prices quoted are based on the cost of material, labour, transport and of conforming to statutory obligations ruling at the date of tender and if between that date and the date on which goods are dispatched, variations either by rise or fall occur in these costs, then the prices quoted shall be amended to provide for these variations.

In the event of an order the contract would also be subject to the following clause.

(*b*) The Contractor shall be relieved of Liabilities incurred under this Contract wherever and to the extent to which the fulfilment of such obligations is prevented, frustrated or impeded as a consequence of conforming to any Statute, Rules, Regulations, Orders or Requisitions issued by any Government Department, Council, or other competent authority.

APPENDIX II

PUBLICATIONS BY THE AUTHOR

1. *Organisation und Selbstkostenberechnung in Maschinenfabriken* (Organization and Calculation of Costs in Machine-factories). Third revised and greatly enlarged edition, Julius Springer, Berlin, 1926.
2. *Ueber die Eingliederung der Normungsarbeit in die Organisation einer Maschinenfabrik* (Linking Standardization with the Organization of a Machine-factory), Julius Springer, Berlin, 1924.
3. *The New Management*, by H. T. Hildage, T. G. Marple, and F. L. Meyenberg, Macdonald and Evans, London, 1938.
4. *Economic Control of Iron and Steel Works*, Chapman & Hall, Ltd., London, 1942.
5. *Time Study and Rate Fixing*, The Engineers' Digest and Sir Isaac Pitman & Sons, Ltd., London, 1945.
6. Articles in the periodicals: *Engineer*, *Engineering*, *Iron and Steel*, *Metallurgia*, *Machinery*, *Machinist* (European Ed.) in the years 1938 to 1944.

APPENDIX III

LITERATURE ON INDUSTRIAL LEGISLATION

THOSE readers who want more details of the legislation affecting industry than it would be possible to give in the present book, are referred to the following publications. They have been chosen from the great number of such books because they are fairly up to date and, whilst giving full and detailed information, are written for the layman rather than the specialist law student.

1. *Palmer's Company Guide*, 36th edition by J. Charlesworth, published by Stevens & Sons, Ltd., London, 1948.

2. *The Worker and the State*, by Sir Frank Tillyard, 3rd edition, published by George Routledge & Sons, Ltd., London, 1948.

This book is a classic in its field; the table of contents is given below to give the reader an impression of the spirit in which this book has been written.

The contents of Tillyard's book are divided into seven sections—

I. Introduction.
II. Legislation as to Wages.
III. Time Conditions Improved by the State (Complete and Partial Prohibitions).
IV. The State and the Safety of the Workers.
V. The State and the Health of the Workers.
VI. The National Insurance Act, 1946.
VII. The State and Trade Disputes.

Special attention should be given to Section II, dealing with—

(1) The Statutory Determination of Wages (Minimum Wages Legislation);
(2) Statutory Enactment as to the Ascertainment of Wages (Particulars and Check-weighing);
(3) Statutory Safeguards as to the Payment of Wages (Truck Acts);
(4) Statutory Facilities for Recovering Wages;

and to Section VII, dealing with Trade Unions, Trade Disputes, and Conciliation.

3. *Factory Law*, by Clara D. Rackham, published by Thomas Nelson & Sons, Ltd., London, September, 1938; reprinted 1944 and 1947.

4. *Redgrave's and Owner's Factory, Truck and Shops Acts*, being the 15th edition of Redgrave's *Factory Acts*, by Joseph Owner; published by Butterworth and Co. (Publishers), Ltd. and Shaw & Sons, Ltd., London, 1939; with a supplement of 1943.

5. *Handbook to the Factories Acts and Truck Acts*, by J. Owner, third edition, published by Sir Isaac Pitman & Sons, Ltd., London, 1945.

6. *Management and Men.* A study of the Theory and Practice of Joint Consultation at all Levels, by G. S. Walpole, published by Jonathan Cape, London, 1944.

7. *British Trade Unions*, by M. Turner-Samuels, published by Sampson Low, Marston & Co., Ltd., London, 1949.

APPENDIX IV

RECOMMENDED BRITISH AND AMERICAN PUBLICATIONS ON THE TASK AND THE RESPONSIBILITY OF MANAGEMENT

1. *Valid Incentives*—The Fallacy of so-called "*Payment by Results*" *Systems*, a paper given by E. C. Gordon England before a meeting of the London Region of the Institute of Economic Engineering in June, 1948. The full text of this paper has appeared in the meantime in the *Journal of the Institute of Economic Engineering*, 28 Victoria Street, London, S.W. 1, of March, 1949.
2. *The Nature and Significance of Management*, by E. F. L. Brech, B.A., B.Sc. (Econ.), M.I.I.A., London, 1946.

Although Brech's book consists of only 120 pages, it contains such an abundance of valuable considerations set out in such clear language that its study is recommended to all.

3. *The Production Engineer in Relation to National Economy*, by B. H. Dyson, M.I.P.E., F.I.I.A. (Published in the *Journal of the Institution of Production Engineers*, Vol. 28, March, 1949, pp. 129–142.)
4. *Rules of Management*, by M. C. Routy, at the American Management Association Convention, May, 1930.

(i) Definite and clear-cut responsibility should be assigned to each executive.

(ii) Responsibility should always be coupled with corresponding authority.

(iii) No change should be made in the scope of responsibilities of a position without a definite understanding to that effect on the part of all persons concerned.

(iv) No officer or employee occupying a single position in the organization should be subject to definite orders from more than one source.

(v) Orders should never be given to subordinates over the head of a responsible officer. Rather than do this, the officer in question should be supplanted.

(vi) Criticism of subordinates should, whenever possible, be made privately, and in no case should a subordinate be criticized in the presence of officers or employees of equal or lower rank.

(vii) No dispute or difference between officers or employees as to authority or responsibility should be considered too trivial for prompt and careful adjudication.

(viii) Promotion, wage changes, and disciplinary action should always be approved by the officer immediately superior to the one directly responsible.

(ix) No officer or employee should ever be required or expected to be at the same time an assistant to and critic of another.

(x) Any officer whose work is subject to regular inspection should, whenever practicable, be given the assistance and facilities necessary to enable him to maintain an independent check of the quality of his work.

5. *Management and Morale*, by F. J. Roethlisberger (Critical review published in *Scope*, Dec., 1944).
6. *A Rebel Yells*, by H. Frederick Willkie, New York, Van Nostrand; London, Macmillan, 1946.

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